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SOUTHWESTERN WASHINGTON RIVER BASINS
TYPE IV SURVEY

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1974

FOREST SERVICE PHOTO

prepared by

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
ECONOMIC RESEARCH SERVICE
FOREST SERVICE
STATE OF WASHINGTON

USDA-SCS-PORTLAND, OREG. 1979

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SUMMARY

GENERAL DESCRIPTION

The Southwestern Washington River Basin study area is bounded by the Columbia River on the south and the Pacific Ocean on the west. The northern boundary is the Strait of Juan de Fuca. On the east, the area is bounded by the Olympic Mountain crest and the natural divide between the Puget Sound and Southwestern Washington drainages, the Cascade Mountain crest between Mountain Rainier and Mount Adams, and the natural divide marking the Lewis River drainage between Mount Adams and the Columbia River.

Southwestern Washington has a total area of 7,497,100 acres, of which 7,020,170 acres are land and 476,930 acres are water. The area includes all of Clark, Cowlitz, Grays Harbor, Pacific, and Wahkiakum Counties, most of Lewis County, and parts of Jefferson, Clallam, Thurston, Mason, Skamania, Pierce, and Yakima Counties.

The Basin is comprised of four different physiographic provinces--the Cascade Mountains, Puget-Willamette Trough, Coast Range, and Olympic Mountains. The Cascade Mountain Province is characterized by rough and mountainous volcanic highlands and their foothills. The Puget-Willamette Trough is characterized by areas of low relief consisting mainly of benches, plains and low rounded hills. The Coast Range Province consists of centrally located rugged mountainous uplands, a surrounding belt of low hills, and relatively broad, flat flood plains and terraces located near the outer fringes of the province. The Olympic Mountains Province is dominated by extremely rugged sharp peaks and steep-sided valleys, but also includes a broad dissected terrace extending westward to the Pacific Ocean.

Climate is a modified maritime type with 80 percent of precipitation falling between October and March. Annual amounts range from 70-100 inches over the Coastal Plains, 125-200 inches in the rain forest area of the Olympics, and 40-60 inches along the western slope of the Cascades. The frost-free season ranges from 150-200 days.

Most of the basin is heavily forested, with Douglas-fir the most important timber species. Other important forest types are the true-fir-mountain hemlock association in the highlands, the Pacific silver fir-western hemlock association in mid-elevations, and the sitka spruce-western red cedar association along the coast. The principal grasses are tickle grass and meadow fescue; but moss, lichens and ferns are also found. Tidal flats have a salt cover, and fresh water marshes commonly have a cover of grass and sedges.

Only 20 percent (1,360,000 acres) of Southwestern Washington has a potential for crop production. Much of this land has problems that reduce the land's productive potential and increase farming costs. The other 80 percent is best suited for forest, grass, wildlife habitat, recreation and water supply.

Public ownership is divided nearly equally between the State of Washington and the federal government and amounts to 43 percent of the total land area. Much of the private land is in large corporate holdings such as Weyerhaeuser Company, Crown Zellerbach, ITT-Rayonier and other timber owners. The remaining private land is in farms, woodlots, cities and rural areas. About 230,000 acres is Indian land.

Forest land covers nearly 88 percent of the land area in Southwestern Washington. Cropland constitutes only 5.5 percent of the total land area and is located primarily along the Chehalis River and its tributaries and in southern Clark County.

Mean annual runoff is 73 inches, or 42,600,000 acre-feet. This is at least seven times the mean annual runoff for the conterminous United States (less than 10 inches per year). Location is variable, however, and water may not be available where and when it is needed. Reservoirs having more than 5,000 acre-feet of storage have been constructed on the Lewis, Cowlitz, Skookumchuck, and Wynoochee Rivers. Small lakes, ponds, and reservoirs have a total surface area of about 34,500 acres. Glaciers and perennial snowfields are located in the headwater areas of the Lewis and Cowlitz River basins and in the higher parts of the Olympic Peninsula. The sanitary quality of water in streams is suitable for most uses with little treatment. Ground water quality rates good to excellent for most uses, with few exceptions.

Salt water estuaries and coastal rivers provide good aquatic habitat for numerous species of anadromous and resident fish. The area also provides habitat for a wide variety of wildlife, including big game species, game birds, and migratory waterfowl.

Population of Southwestern Washington is about 327,000. Distribution is half urban and half rural, with a slow trend toward urbanization. Median school years completed is 10.9, which is lower than the state median. Principal sectors of employment are manufacturing, services, and retail trade.

During the past twenty years there has been a substantial decrease in number of farms and acreage of land in farms in Southwestern Washington. Decrease in number of farms has been over two times the statewide decrease on a percentage basis. Major crops are associated with livestock industries. Berry crops are also important. Vegetable acreage has tripled in the last 25 years.

A high percentage of the Basin's land area is available for some form of recreation. Included are camping, picnicking, swimming, boating, hunting, fishing, hiking, and sightseeing. Recreation areas are in both public and private ownership.

ECONOMIC PROJECTIONS

Population is projected to increase to nearly 500,000 persons by 2020, with an associated employment participation rate of nearly 40 percent. Major employment sectors in 2020 are projected to be in manufacturing, retail trade, and services. There is a projected continued decline in rural farm population. The volume of major crops produced in the area is projected to increase significantly. The forest products industry will remain the leading manufacturing industry in terms of total earnings.

By the year 2020, cropland will increase nearly 48,000 acres, due to increased requirements of hay and silage to support an expanding livestock and dairy industry.

PROBLEMS AND OPPORTUNITIES

Principal areas of erosion and sediment production are logging access roads, clear-cut logging areas, and urban development. Streambank, beach, and shore erosion problems are relatively moderate, with local exceptions.

There are approximately 800,000 acres in the Basin that could flood at least once in a 100-year period. A high percentage of these lands is in forest or natural vegetation and would not suffer serious monetary damage. The worst flooding problems occur in the vicinity of the Chehalis River and tributaries, the Willapa River, the Cowlitz River and tributaries, and the Lewis River. Dollar cost of floodwater damages is 67 percent urban.

Excess water is the dominant hazard or limitation in the use of land suited to cropland. More than one-third of the potential cropland suffers this limitation. Though over 140,000 acres could profit economically from irrigation based on crops presently grown, only 30,000 acres are presently irrigated.

Land use problems include urbanization of forest and agricultural lands, and urban development on flood plains or in areas of severe septic tank limitations.

PROGRAMS AND PROJECTS

There are 18 projects in 15 small watersheds which have been identified for early action in Southwestern Washington. The primary purpose of 17 of the projects is flood prevention--the other is water storage. All of the projects include some of the following as secondary purposes: land treatment for watershed protection, drainage, irrigation, water quality, municipal and industrial water supply, recreation, and fish and wildlife enhancement.

There are 123 potential reservoir sites for water storage which have been identified on a preliminary level.

Over 700,000 acres of wildlife habitat are scheduled for improvement, as well as 35 acres of lakes and 145 miles of stream.

Erosion and sediment control measures are included in all programs and projects. Approximately 91,500 acres of forest land have been identified as needing some treatment. An additional 8,000 acres of urban and agricultural lands also need sediment control.

Since practically 90 percent of the area is forest, many programs and projects in the early action period have to do with forest management, protection, and the preservation of forest soils. Accelerated fire protection work has been identified for more than 15,000 acres of national forest. To increase the production of lumber and fibre, and thus provide jobs, 33,000 acres of national forest land and 1.7 million acres of state and private forest lands which are nonstocked or understocked need to be planted. Timber stand improvement practices, such as thinning, would benefit over 90,000 acres of national forest and nearly 885,000 acres of state or private forest. Much of the area's recreation occurs in the public and private forests. To meet projected demands, an additional 8,000 acres will have to be allotted for campground and related facilities by the year 2020.

EXPANDED FOUR-ACCOUNT DISPLAY

The following display summarizes problems and objectives, possible measures, and potential program and project opportunities for the entire Southwestern Washington study area. It follows the basic format of a four-account display as presented in "USDA Procedures for Planning Water and Related Land Resources" under the Principles and Standards of the Water Resources Council, with special additions to meet the needs of this particular study. In addition to National Economic Development, Environmental Quality, Regional Development and Social Well-Being accounts, the display includes a listing of problems and objectives discussed in the narrative. Structural and nonstructural measure plan elements are outlined, along with the extent to which known existing problems and objectives are satisfied and the needs which remain. Quantitative amounts are measured in units and degree of accuracy consistent with the nature of the problem or objective and the time frame involved. Project and program opportunities include those having undergone preliminary study and those noted only as possibilities for agencies within the Department of Agriculture, as well as any other agency, including state, county, municipal, district, and local entities.

Problems and Objectives*	Measure Plan Elements: Structural: Channels	Structural: Dams (No.): FF	Structural: Dams (No.): Mul	Structural: Dikes	Nonstructural: Land Treatment	Nonstructural: Land Purchase	Plan Provisions	Remaining Needs	Areas Needing Individual or Small Group Action	National Economic Development: Beneficial : Adverse (thousands of dollars)	Environmental Quality: Beneficial and Adverse Effects	Regional Development: Beneficial (thousands of dollars)	Regional Development: Adverse (thousands of dollars)	Social Well-Being: Beneficial and Adverse Effects	Later Action: Project and Program Opportunities: U.S. Department of Agriculture: Current* (No. and Type)	Later Action: Project and Program Opportunities: U.S. Department of Agriculture: Potential (No.)[a/]	Other Agencies
Erosion and sediment reduction Sheet, rill, and gully 150,000 acres					126,000 acres		126,000 acres	24,000 acres	24,000 acres	non-monetary 1,886.8	A. Protection and enhancement of 104,000 acres Aids in fire protection B. Reduces sediment pollution of waterways Reduces sediment pollution of Willapa Bay and estuary and Grays Harbor Prevents erosion and restores eroded areas Chinook project reduces erosion rate from 3.0 T/ac to 1.5T/ac. Erosion and sediment yields in other project areas are minimal	Income: nonmonetary	Cost-shared	B Stabilized runoff reduces flood hazard Reduced sediment yields alleviate sediment damage to waterways and estuaries C. Improves quality of recreation areas	13 PL-566[b/] 5 RC&D[b/] Studies on upland and beach and shore erosion	39 possible sites Stream management program: East Fork Lewis River, Lake River, Salmon Creek Projected additional need: sheet, rill, and gully 400,000 acres streambank 2,200 miles beach and shore 45 miles roadbank 2,000 miles gully stabilization 50 miles	Corps of Engineers - beach and shore erosion in Chehalis and South Coastal subareas Cowlitz River Gravel Study Committee - study gravel deposits in the lower Cowlitz River
Streambank 885 miles					885 mi		885 mi.	0		25,791.0							
Beach and shore 45 miles							0	45 miles									
Roadbank 1,250 miles					1,250 mi		1,250 mi.	0									
Fire protection 104,000 acres					104,000 acres		104,000 acres	0		3,357.0							
Gully stabilization 30 miles					30 miles		30 miles	0		50.0							
Flood damage reduction Urban 25,000 acres	113.8 mi.	6		6.4 mi	54,700 acres	3,326 acres	3,500 acres	21,500 acres	1,200 acres	46,400.5 19,838.7 net..... 26,561.8 benefits	A. Create lakes 2,130 surface acres B. Stored water may be used in upgrading water quality Improved ground water table assists in sanitary sewage treatment for protection of ground water quality Reservoirs reduce sediment pollution by serving as settling basins C Improves 4,000 acres of wildlife habitat by increasing food and water supplies and by removing trash and siltation Creates 2,130 surface acres of fish habitat and waterfowl resting area Eliminates salt water damage to vegetation at South Bend Preserves 4 acres of Type 12 wetlands Disrupts the aquatic ecosystem on 15 miles of stream Lose: 1,639 acres Type 1 wetland[c/] 446 " " 2 " 33 " " 6 " 23 " " 7 " 737 " wildlife habitat 600 " deer and elk range small portion of anadromous fish spawning area in South Fork, Willapa, and above Salzer Creek Dam E. Approximately 15 acres or ground will be occupied by structures	Income: 29,204.6 8,813.8 net benefits 20,390.8 Employment: 900 man-years 550 skilled 225 semiskilled 125 unskilled		A. Creates 925 permanent low-to-medium income jobs Relocates 8 part-time farms and 2 full-time farms B Provides protection from the once in 100-year flood to certain urban areas in and around McCleary, North Grayland, Elma, Raymond, Satsop, South Bend, Centralia, Chehalis, Vancouver, Twin Harbors, Westport, Lexington, State Park Allows proper operation of sewage treatment facilities Provides protection to domestic water supply Aids in vector control C. Protects educational, cultural, and recreational facilities within project Provides 543,000 activity days of recreation at reservoirs	12 PL-566 5 RC&D 18 flood hazard studies	73 possible sites	Corps of Engineers - jetties near Ocean Shores, Westport; general flood control on lower Willapa River, Upper Cowlitz River, at Raymond; erosion and flood control near Tokeland-North Cove; levees, pump plants, and canals near Randle, Lake River Delta, lower Kalama River, Columbia River, Vancouver Lake, Lake River; flood plain information and floodway designation studies State-Flood Control Laws, Shoreline Management Act Local government-planning and zoning
Agricultural 291,000 acres							33,900 acres	257,100 acres	33,100 acres								
Drainage 323,000	[c/] mi.[d/]						26,900 acres	296,700 acres	110,400 acres	18[b/] 92 net benefits 93	See "Flood damage reduction," above	Income[d/] Employment[d/]		A See "Flood damage reduction," above B Improved ground water table aids sanitation and protects ground water quality) Aid vector control	12 PL-566[d/] 5 RC&D[d/] FmHA loans	75 possible sites	State - State Water Quality Standards diking districts - along the Columbia River. Diking districts - along the Columbia River
Water supply M&I 66.7 mgd Stream flow augmentation Lake stabilization	10.6 mi.	1			2,800 acres	640 ac.	2.8 mgd	63.9 mgd		3,903.9 8,838.6 net benefits ... 65.9	A. Creates a lake with 300 surface acres B. Provides water for use in sanitary sewage treatment, thereby protecting water quality Reduces sediment pollution by serving as a settling basin C. Improves wildlife habitat by increasing food and water supply Creates 300 acres fish habitat and waterfowl resting area Lose 320 acres wildlife habitat, small portion of anadromous fish spawning area E. Approximately 5 acres will be occupied by structures	Income 7,954.0 7,905.8 Net benefits 48.2 Employment: 400 man-years 250 skilled 100 semiskilled 50 unskilled		A Creates 350 permanent low-to-medium income jobs Raises the income of farmers using irrigation water B. Provides a stable water supply to Long Beach Peninsula C. Provides 50,000 activity days of recreation	1 PL-566 Col-Pac RC&D water supply study on the Long Beach Peninsula	51 possible sites 126 potential reservoir sites FmHA loans May also use the 6 flood prevention dams Projected additional municipal, industrial and rural water supply needs 62.5 mgd	Corps of Engineers - could develop Wynoochee Dam for M&I water Bureau of Reclamation - sources near Doty-Dryad and Chehalis; Bear River could be either BR or SCS; could use projects noted for drainage and irrigation, above U.S. Geologic Survey - ground water availability studies State - Municipal, Industrial, and Rural Water Supply appendix PUD - Lewis County dam at Cowlitz Falls Tacoma City Power & Light - supply northern half of Lewis Subarea from Swift Creek Reservoir, Yale Lake, Lake Merwin Water districts - M&I water distribution for Long Beach Peninsula and vicinity
Water quality Study area need is not yet quantified	224.4 mi.	[b/] [e/]	[e/]	6.3 mi.[d/]	57,600 ac.[b/]	3,966 ac.[b/]					No projects as such			No projects as such	Septic tank and sanitary landfill soil suitability studies Monitoring and control techniques Forest Management and Protection and improved harvest system design	11 possible sites Regional water transmission system from Wynoochee to North and South beach communities	CRAG - investigation of water needs and distribution systems for Vancouver State-water quality studies Counties - zoning, regulate lot size to protect shallow wells Water treatment plant for Kelso-Longview

Notes: a/ may be PL-566, RC&D, PL-46, ACP, private or other
b/ includes units shown for flood damage reduction
c/ mostly hay and pasture
d/ included in Flood damage reduction
e/ includes units shown for water supply
f/ total of flood damage reduction and water supply projects

* larger numbers have been rounded

SOUTHWESTERN WASHINGTON RIVER BASIN STUDY AREA

Early Action Problems and Objectives*	Measure Plan Elements: Structural: Channels	Structural: Dams (No.): FPP	Structural: Dams (No.): H&I	Structural: Dikes	Nonstructural: Land Treatment	Nonstructural: Land Purchase	Plan Provisions	Remaining Needs	Areas Needing Individual or Small Group Action	National Economic Development: Beneficial : Adverse (thousands of dollars)	Environmental Quality: Beneficial and Adverse Effects	Regional Development: Beneficial Adverse (thousands of dollars)	Social Well-Being: Beneficial and Adverse Effects	Later Action: Project and Program Opportunities: U.S. Department of Agriculture: Current (No. and Type)	Later Action: Project and Program Opportunities: U.S. Department of Agriculture: Potential (No.)[e/]	Other Agencies
Land Use Urban encroachment Soil suitability to residential development Water management Timber stand improvement 975,000 acres	113.8 mi.[b/] 124.4 mi.[f/]	6[b/] 6[b/]			54,700 ac.[b/] 57,600 ac.[b/]	3,326 ac.[b/] 3,966 ac.[b/]					See "Flood damage reduction," "Drainage," "Irrigation," and "Water supply," above		See "Flood damage reduction," "Drainage," "Irrigation," and "Water supply," above	13 PL-566[b/] 5 RC&D[b/] 18 flood hazard studies[b/] Forestry Incentives Program Technical assistance for land use planning Forest Service timber stand improvement 90,000 acres FmHA loans ASCS-RECP & REAP		State - Forest Land Tax Act, Open Space Taxation Act, Shoreline Management Act, Hydraulics Act, State Water Quality Standards
Recreation Water-related facilities 8,500,000 activity days Recreation sites 2,200 acres		5[d/]	1[e/]				593,300 activity days on 6 watersheds 560 acres of development in National Forests	7,400,000 activity days			A. Total of 2,430 surface acres of lakes created by projects discussed above for flood damage reduction and water supply Site improvement - 560 acres		A, B. See "Flood damage reduction" and "Water supply" above C. Provides a total of 593,300 fresh-water activity days	Forest Service - develop recreation potential on Wynoochee Reservoir Recreation site improvement Assist private development of recreation sites on farm and woodland	52 possible sites	State - clean up O'Neill Lake Counties - develop Failer Lake State, county, and local government - construct 1,600 acres of camp, picnic and other recreation development sites
Fish and Wildlife Habitat quality and encroachment		6[b/]	1[e/]		898,600 ac.[b/ e/] of land 5,745 mi of water 35 acres of lake						A. Improves natural appeal of project area B. Nonstructural measures reduce all types of pollution to habitat C. Creates 2,430 surface acres fish habitat and waterfowl resting area Survey and analysis 765,000 acres of land 5,600 acres of water Improve habitat fish - 145 miles of stream 35 miles of lake waterfowl - 100 acres big game - 3,600 acres general habitat - 126,000 acres project-area habitat - 4,000 acres		C. Enhances enjoyment of wildlife resources	Forest Service - habitat improvement for fish, waterfowl, and big game 13 PL-566 5 RC&D	27 possible sites	State - fish and wildlife resource management
											A. Areas of natural beauty B. Water, land, and air quality C. Biological resources and selected ecosystems E. Irreversible or irretrievable commitments of resources to future uses		A. Real income distribution B. Life, health, and safety C. Educational, cultural and recreational			

Notes:
a/ may be PL-566, RC&D, PL-46, ACP, private or other
b/ includes units shown for flood damage reduction
c/ mostly hay and pasture
d/ included in flood damage reduction
e/ includes units shown for water supply
f/ total of flood damage reduction and water supply projects

* larger numbers have been rounded

INTRODUCTION

INTRODUCTION

The Columbia-North Pacific framework study focused attention on land and water resources of the Northwest. It showed how the expanding population of the United States will create need for additional production from and use of limited land and water. Increased use can create problems and these should be anticipated in planning.

As a basis for proper resource planning, it was necessary to inventory and appraise natural resources, expected population growth, and developments dependent on water and land.

Once a resource inventory is completed, the problems and opportunities can be identified. It is then possible to visualize alternate ways and costs for satisfying increased demand for goods and services expected to result from economic growth.

In June 1967, the State of Washington invited the United States Department of Agriculture to participate in a Type IV River Basin study of Southwestern Washington. The scope and intensity was to be similar to an earlier type II river basin study covering the Puget Sound area. A plan of work for the Southwestern Washington river basin study was drawn up and agreed to on July 31, 1968. Although a misnomer in the strictest sense of the term, "Basin" is used to designate the Southwestern Washington Study Area.

LOCATION AND SETTING

The river basin study is located in Southwestern Washington as the title implies, (Figure 1). Bounded by the Columbia River on the south and the Pacific Ocean along the entire western side, the northern boundary of the Basin is the Strait of Juan de Fuca. On the east the boundary is the crest of the Olympic mountains and the natural divide which separates Puget Sound from Southwestern Washington drainages. The crest of the Cascade Mountains form the eastern boundary between Mount Rainier and Mount Adams. The natural divide separating Lewis River basin from White Salmon, Little White Salmon, Wind River and Rock Creek forms the southeast boundary between Mount Adams and the Columbia River.

The Basin contains all of Clark, Cowlitz, Grays Harbor, Pacific and Wahkiakum Counties, and most of Lewis County. Also included are portions of Jefferson, Clallam, Thurston, Mason, Skamania, Pierce and Yakima Counties.

SOUTHWEST WASHINGTON STUDY AREA

1974

FIGURE 1

U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

The Southwestern Washington River Basin has been divided into five hydrologic regions or subbasins - Olympic, Chehalis, South Coastal, Cowlitz and Lewis. In this report, the resources, problems and opportunities, and solutions are discussed in a general way for the entire Basin and specific data and recommendations have been developed and presented for each Subbasin.

OBJECTIVES AND SCOPE

The primary study objective is to facilitate the coordinated conservation, development, utilization, and management of water and related land resources. Programs will be formulated to promote economic growth and development yet preserve the quality of the environment. Particular attention was given to identification and study of land and water related projects and programs suitable for early action. Consideration is given to: (a) the timely development and management of resources as an essential aid to the economic growth of Southwestern Washington; (b) the protection and improvement of resources to insure that they continue to be available for their best use as needed; and (c) the well-being of the people as the overriding determinate in such planning. Use was made of available data and the interdisciplinary judgment of professional technicians in various specialties.

The State of Washington has an additional objective to utilize portions of this study as inputs to the State Water Plan. The Water Resource Act of the State Legislature (1971) directed the State Department of Ecology,

> ".....as a matter of high priority to insure the waters of the state are utilized for the best interests of the people, to develop and implement.....a comprehensive state water resource program which will provide a process for making decisions on future water allocation and use."

The State Water Resource Plan was not intended to be a rigid blueprint for all future development of water and related resources of the state, but to vary in detail from basin to basin and to retain flexibility for response to future needs.

COOPERATING AGENCIES

Participation of the U.S. Department of Agriculture in this study is by authority of Section 6 of Public Law 566, 83rd Contress, as amended. Representing the USDA are the Economic Research Service, Soil Conservation Service, and Forest Service. The participation of these agencies is conducted in accordance with a memorandum of understanding, executed April 15, 1968, and forms the basis for assisting the state in planning development of water and related land resources in the Southwestern Washington Basin.

Several other USDA and closely associated agencies are active in the field of water and related land resources in the Southwestern Washington Basin. Some of them are:

Agricultural Research Service
Agricultural Stabilization and Conservation Service
Extension Service
Farmers Home Administration
Rural Electrification Administration
Experiment Stations
State Universities and Colleges

Other federal agencies which have contributed or assisted in various ways are:

U.S. Army Corps of Engineers, Portland and Seattle Districts
U.S. Bureau of Indian Affairs
U.S. Park Service
U.S. Bureau of Reclamation

Participation of the State of Washington is through the State Department of Ecology, established by the Washington State Legislature in Chapter 43.21A, Laws of 1970. This department administers the State's water resources, including various functions of management, conservation, utilization, adjudication, planning, and development. The Water Resources Act of 1971 directs the Department to develop a State Water Resources Program. The Department of Ecology will coordinate major portions of this study.

Thirteen of the principal state agencies are listed.

Department of Agriculture
Department of Commerce and Economic Development
Department of Fisheries
Department of Game
Department of Highways
Department of Natural Resources
Department of Social and Health Services
Interagency Committee for Outdoor Recreation
Parks and Recreation Commission
Office of Program Planning and Fiscal Management
Planning and Community Affairs Agency
State Soil and Water Conservation Commission
Attorney General

PUBLIC INVOLVEMENT

Viewpoints of local citizens were of major significance in identifying problems and preferences among alternative solutions to these problems. To facilitate this effort, the State Department of Ecology engaged the services of several senior college students during the summer of 1970. Approximately 30 people were interviewed in each of eleven counties. Opinions were purposely selected from individuals close to water resource related problems and with specific knowledge of the county as a result of jurisdictional responsibilities. Among individuals interviewed were county commissioners, county and regional planners, public utility district managers, fish and game specialists, industry officials, U.S. Department of Agriculture personnel, County Extension Service chairmen and citizens actively involved in resource planning and development.

The principal objectives of interviews were to expand local awareness of the Southwestern Washington Type IV survey and the State Water Program, establish a means for obtaining local input and participation and to document the local problems and needs as seen by local residents.

During April of 1974, a series of public meetings were jointly organized by the State Department of Ecology through the Extension Service and Soil Conservation Service. Meetings were held in Cathlamet, Kelso, South Bend, Chehalis, Montesano and Vancouver representing 6 counties within the survey area. Representatives of the Forest Service and Economic Research Service also participated in these meetings. In addition, meetings with local governmental planning and agency officials were held at Port Angeles and Forks in Clallam County. Jefferson County Planning Staff members attended the meeting at Port Angeles.

Concerns and opinions expressed during interviews and public meetings were influential in identifying major problems and acceptable solutions. These expressions have affected the selection of solutions presented in the study.

RESOURCE INVENTORY

The need for a data storage and retrieval system with the capability of managing a large volume of soil and land resource data prompted the selection of a computer based system pioneered by the Forest Service and adapted to the needs of the Southwestern Washington survey.

Commonly referred to as MIADS, an acronym for Map Information Assembly and Display System, the method utilizes a set of computer programs and produces computer maps with tabular summaries of soil and land resource facts. Information can be replaced, updated or displayed in original form on request. The basic maps in storage are subject to retrieval, and in addition, the system is able to generate new maps and summaries from translation of data and/or by combining two or more basic, translated or previously combined maps.

Tables of basic resource data, combinations and interpretations displayed in the report were generated by the MIADS program from survey inputs. These tables represent a small percentage of the more than 200 which the system produced. Many more are possible if needs are identified. It would have been virtually impossibl with available staffing to manually develop the number of tables involving two or more combinations of resource data which MIADS produced.

The MIADS inventory program was supported financially by the State Department of Ecology. Inventory data inputs were furnished by the Soil Conservation Service with programming and data processing occurring at the Albrook Laboratory at Washington State University.

NATURAL RESOURCES

NATURAL RESOURCES

Southwestern Washington has a total area of 7,497,100 acres, of which 7,020,170 acres is land and 476,930 acres is water surface. The area includes all of Clark, Cowlitz, Grays Harbor, Pacific, and Wahkiakum Counties, and most of Lewis County; also parts of Jefferson, Clallam, Thurston, Mason, Skamania, Pierce, and Yakima Counties.

For this report, Southwestern Washington was divided into five subbasins--Olympic, Chehalis, South Coastal, Cowlitz, and Lewis.

The Olympic subbasin in the north contains 2,010,300 acres and consists of 31 tributary watersheds. Three major lakes--Ozette, Crescent, and Quinault--are located in the subbasin. The Hoko River flows northward from the Olympic Mountains into the Strait of Juan de Fuca. Four major rivers--Quillayute, Hoh, Queets, and Quinault--flow southwestward from the Olympic Mountains into the Pacific Ocean. Other major rivers--Dickey, Soleduck, and Bogachiel--flow southwestward and westward into the Quillayute River. Another river, Calawah, flows westward into Bogachiel River.

The Chehalis subbasin in the central part of the area contains 1,728,700 acres and consists of 55 tributary watersheds. The Chehalis is the major river flowing northwestward into Grays Harbor Bay. Three other rivers--Humptulips, Hoquiam, and Wishkah--flow from the north into Grays Harbor Bay. Other rivers--Wynoochee, Satsop, and Cloquallum--also flow from the north, but run into the Chehalis River. The Skookumchuck River flows westward and the Newaukum River flows northwestward into the headwaters of the Chehalis River.

The South Coastal subbasin in the southwestern part of the Basin contains 1,006,300 acres and is divided into 52 tributary watersheds. Three major rivers--North, Willapa, and Naselle--flow westward into Willapa Bay. The Grays and Elochoman Rivers flow southwestward into Columbia River.

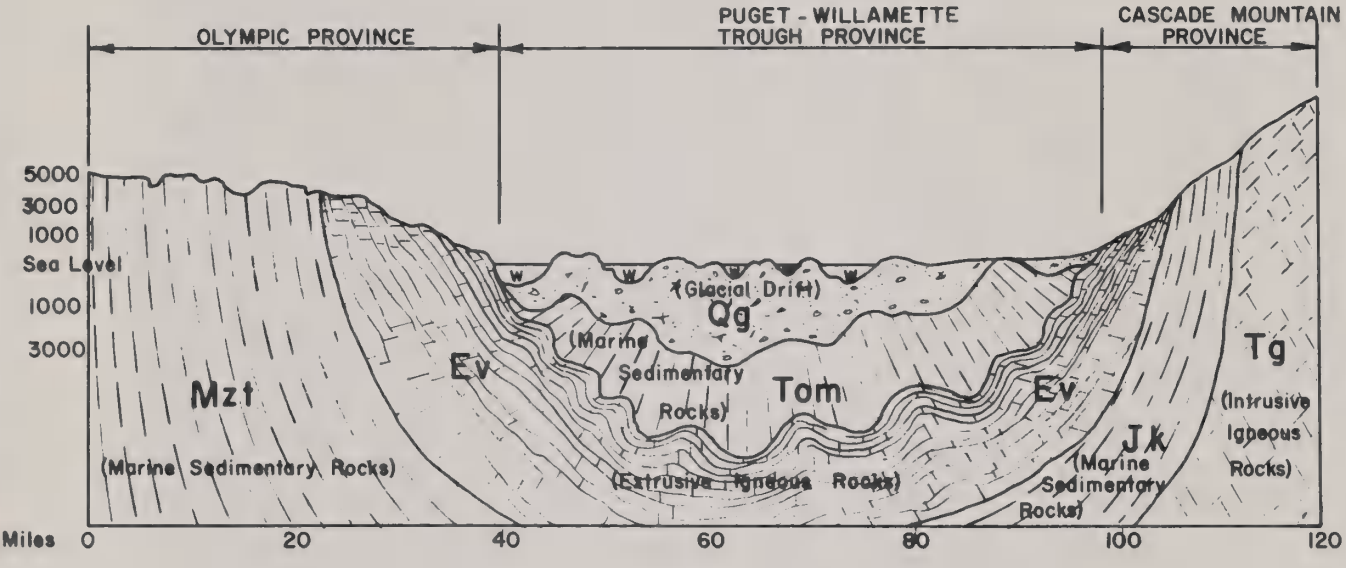
The Cowlitz subbasin in the east-central part of the Basin contains 1,597,800 acres and has 34 tributary watersheds. Four major lakes--Silver, Mayfield, Riffe, and Spirit--occupy the subarea. Cowlitz is the major river flowing southwestward into the Columbia River. Three other rivers--Coweman, Toutle, and Cispus--flow westward into Cowlitz River. Green River flows westward into Toutle River.

The Lewis subbasin in the south contains 1,154,000 acres and has 29 tributary watersheds. Three manmade reservoirs--Swift, Yale, and Merwin are located within the subbasin. The Lewis is the major river and with the Kalama River flows westward into the Columbia River. The Washougal River flows southwestward into the Columbia River.

PHYSIOGRAPHY AND GEOLOGY

A great variety of land forms exist. The Basin includes all or parts of four separate physiographic provinces--Cascade Mountains, Puget-Willamette Trough, Coast Range, and Olympic Mountains, three of which are depicted by the profile shown below. Figure 2 provides a map of major geologic features of the Basin.[1/]

IDEALIZED GEOLOGIC PROFILE
PUGET-WILLAMETTE-TROUGH



The Cascade Mountain Province makes up the southeastern part of the Basin and is characterized by rough and mountainous volcanic highlands and their foothills. The province includes the glacier-clad peaks of Mount St. Helens, Mount Adams and Mount Rainier, with elevations of 9,671, 12,307 and 14,410 feet above sea level, respectively. Most of the land is above 2,000 feet in elevation but descends to less than 50 feet near Columbia River. The mountains are dissected by westerly and southwesterly flowing drainage patterns whose streams eventually empty into the Columbia River. Lewis and Cowlitz Rivers are principal drainage systems located within the province.

1/ The generalized geologic map was derived from former Washington State Department of Conservation geologic publications, 1961, 1970.

BASINS

OLYMPIC

CHEHALIS

SOUTH COASTAL

COWLITZ

LEWIS

LOCATION MAP

GEOLOGIC LEGEND

Qal — Alluvial deposits of Quaternary age

Qe — Active dune sand Eolian deposits

Qci — Non-marine sediments of Quaternary age

Tv — Geologic symbol and boundary

Qg — Glacial outwash of Pleistocene age

QTt — Alluvial terrace deposits of late Tertiary to Quaternary age

QTv — Volcanic lava and pyroclastic rocks of late Tertiary to Quaternary age

Ts — Sedimentary rocks of Tertiary age

Tv — Volcanic flows and interbeds of Tertiary age

TMz — Consolidated sedimentary and volcanic rocks of Mesozoic to early Tertiary age

LEGEND

STUDY AREA BOUNDARY

BASIN BOUNDARY

0-84 WATERSHED NUMBER BOUNDARY

INDIAN RESERVATIONS, NATIONAL PARKS AND NATIONAL FOREST BOUNDARIES

TOWNSHIP & RANGE LINES

LAKES & RESERVOIRS

SMALL RIVERS & STREAMS

SALT WATER & LARGE RIVERS

GENERALIZED GEOLOGIC MAP

SOUTHWEST WASHINGTON STUDY AREA

FIGURE 2

The Cascade Range was formed by uplifting Tertiary Age basaltic lavas, pyroclastics, and consolidated sedimentary strata. The uplift of the Cascade Range began during the late Pliocene Epoch and continued on into the Pleistocene Epoch, a period of approximately six million years. Alpine glaciers had a major impact in sculpturing the present topography of the Province. Mount Rainier, Mount Adams, and Mount St. Helens are volcanic peaks formed by the accumulation of viscous andesite lavas on top of the Cascade Mountains.

The south-central part of the Basin lies in the Puget Willamette Trough Province. It is a northsouth trending structural trough extending through the state that lies between the Cascade Mountain Range on the east and Coastal Ranges on the west. The province is characterized by areas of low relief consisting mainly of benches and plains and low, rounded hills. Chehalis River drains most of the northern section, while most of the southern part is drained by the Lewis and Cowlitz Rivers.

Rocks exposed in the Puget Sound province range in age from early Tertiary to Quaternary. They consist of brackish-water, marine and nonmarine sedimentary rocks, with interbedded volcanic rocks. They are faulted and folded, and in most places are buried by poorly consolidated till and outwash from Pleistocene glaciers and Recent Age alluvium. Downwarping of the Puget Sound trough occurred during the late Tertiary Period (Pliocene time), together with the structural development of the Coast and Cascade Ranges.

The Coast Range Physiographic Province forms the southwestern part of the Basin. It extends from Columbia River northward across to Grays Harbor and Lower Chehalis River. The province is bordered on the west by the Pacific Ocean and on the east by the Puget Sound Province. Topographically, the province consists of centrally located, rugged, mountainous uplands, a surrounding belt of low hills, and the relatively broad, flat flood plains and terraces located near the outer fringes of the province. The highest summit within the central uplands, Boistfort Peak, is over 3,000 feet in elevation, but most mountainous uplands are less than 2,000 feet. Numerous streams drain radially from the central core of the Hills, dissecting the area into a maze of steep ridges and V-shaped valleys. These streams eventually form the broad, flat flood plains of Naselle, Willapa, and Chehalis Rivers.

Exposed rock within Willapa Hills is comprised of Tertiary Age marine and nonmarine sedimentary rocks with interbedded volcanic rocks. Deformation of these strata occurred during the late Tertiary Period, producing north-south trending.

The Olympic Mountains physiographic province is dominated by the Olympic Mountains, but also includes a broad dissected terrace extending westward from the mountains to the Pacific Ocean. The Olympic Mountains are extremely rugged. Glacial action during Pleistocene times has sculptured the rock into a series of sharp peaks and steep-sided valleys. Peaks commonly attain altitudes of 6,000 feet, with Mount Olympus having an elevation of 7,954 feet. Glaciers are still abundant throughout the higher elevations. Numerous streams drain radially away from the central portion of the mountains.

Pre-tertiary and Tertiary Age sedimentary and volcanic rocks underlying the Olympic Mountains were uplifted during late Tertiary times. Glacial and Recent Age deposits of silt, sand, and gravel have filled the lower flood plains of the larger drainage systems.

Minerals

A variety of metallic and nonmetallic minerals are found in southwestern Washington, but only a few are presently exploited commercially. Among the minerals which occur are alumina, copper, gold, iron, lead, mercury, silver, vanadium, zinc, manganese, clay, coal, limestone, and silica sand. Mercury and manganese have been the most important metals produced commercially, but little or no production exists at present. Manganese deposits are numerous in Clallam County and 52,000 tons of ore grading 35 percent or higher of manganese dioxide has been produced from the Crescent mining district within the Soleduck River watershed in Clallam County. Mercury in association with coal is prevalent in the Morton mining district in the Tilton River watershed in Lewis County, but presently there is no production.

Coal is an important nonmetallic mineral existing principally in Lewis and Cowlitz Counties. Commercial use at present is associated primarily with fuel for a thermal-electric plant near Centralia. When fully developed, this plant will require 6½ million tons annually.

Sand and gravel is of considerable commercial importance in Clallam, Grays Harbor, Clark and Cowlitz Counties. Such operations are located near metropolitan areas which require aggregate for concrete. Reserves of sand and gravel are very large, but locally sources may become scarce or inadequate because of competing land uses. Crushed stone (mostly basalt) is a valuable mineral commodity. It is used, after crushing, for aggregate and road subgrade material. Commercially it is most important in Jefferson, Lewis and Pacific Counties. In the vicinity of Mount St. Helens in Skamania County pumice is periodically produced to satisfy commercial demands.

CLIMATE 2/

Climate is influenced by topography, location and the mean position and intensity of high and low pressure centers over both the North Pacific Ocean and the North American continent. Prevailing westerly winds bring maritime air over the Basin and produce a moderating influence throughout the year. The area from the ocean beaches to the crest of the Willapa Hills and Olympic Mountains is exposed to the full force of Pacific winter storms. Gale force winds and heavy precipitation occur each winter. To the east, the Cascade and Rocky Mountains are effective in shielding western Washington from outbreaks of cold arctic air in winter.

Precipitation

Late spring and summer are dry seasons for the Basin. Table 1 shows low average precipitation during this period for many locations. It is significant to note that total precipitation for July and August is less than 5 percent of the annual.

In late fall and winter, southwesterly and westerly winds from over the ocean provide a source of moisture during the wet season, beginning in October, reaching a peak in winter, then decreasing in spring. Eighty percent of the annual precipitation falls in the six months October through March. Thunderstorms occur 5-15 days each year. Greatest numbers are in mountainous areas during the summer; however, they have been recorded in all months.

Orographic lifting and cooling of moist air rising along the windward slopes of the Willapa Hills and Olympic Mountains results in a belt of heavy precipitation from the coast to the crest. Annual amounts range from 70-100 inches over the Coastal Plains, 125-200 inches in the "rain forest" area on the western slope of the Olympic Mountains, 40-60 inches or more along the western slope of the Cascades.

During the wet season, rainfall is mostly of moderate or light intensity. Average monthly and annual precipitation amounts are given in Table 1. Measurable precipitation (.01 or more) is recorded on 4-8 days each month in summer, 8-15 days each month in spring and fall, and 15-25 days each month in winter.

2/ Adapted from "Water Resources of Southwest Washington," Dept. of Ecology, June 1972.

Snowfall

Most winter precipitation falls as rain in elevations below 1,000 feet, as rain and snow between 1,000 and 2,500 feet, and as snow in the higher mountains. In the Olympic and Cascade Mountains, snow can be expected in October and often remains on the ground from November until June or July. The higher peaks are snowcapped throughout the year. Winter season snowfall is from 8 to 30 inches in the lowlands, gradually increasing with altitude to 500 inches or more (Table 2).

Terrain, elevation and exposure have an influence on accumulation of snow. Maximum expected depths are 15-30 inches in the lowlands, 30-60 inches in the foothills, 150-200 inches at 3,000 feet, and 200-250 inches above 4,000 feet. In the mountains, density of the snowpack increases from about 30 percent water in early winter to 40 percent or higher in April. Rather severe ice storms occur in a narrow area westward from the Columbia River Gorge to the vicinity of Vancouver. Rather severe ice storms occur in a narrow area westward from the Columbia River Gorge to the vicinity of Vancouver.

Frost Penetration in the Soil

Depth of frost in the soil varies significantly from winter to winter. It is influenced by distance from the ocean, exposure, elevation, vegetation, soil type, snow cover and temperature. In the lowlands, frost reaches depths of 4-8 inches almost every winter and may reach 15 inches or more in exposed areas during extended periods when cold air coincides with no snow cover. Soils under the mountain's snowpack are usually free of frost.

Temperature

During the warmest summer months, afternoon temperatures are in the upper sixties and seventies in the interior valleys. In the mountains, temperature decreases about 3^{o} F. with each 1,000 feet increase in altitude. Maximums exceed 80^{o} F. on 3-15 days in July and August and have reached 90^{o} F. or higher 3-8 days. Minimums are in the forties and fifties producing a daily range of 25^{o}-30^{o} F. The highest temperatures are recorded when air from the interior of the continent reaches this area. In elevations above 5,000 feet, below freezing temperatures are not unusual in summer.

In an average winter, maximum temperatures range from 38^{o}-45^{o} F. and minimums from 28^{o}-35^{o} F. (Table 3). Maximums are below freezing on 3-8 days and minimums drop to 20^{o} F. or lower 5-15 nights. During colder winters, minimums have dropped to 20^{o} F. on 5-20 nights and to 10^{o} F. on 3-10 nights. In the mountains, below freezing temperatures are recorded most nights between October and April.

Table 1 -- Average Monthly and Annual Precipitation in Inches, Southwestern Washington

Area/ Station	Elevation	Period of Record	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual
COASTAL - WEST OLYMPIC															
Aberdeen	12	1931-60	12.70	10.23	9.19	5.56	3.43	2.70	1.51	1.79	3.71	8.13	11.09	14.50	84.54
Clallam Bay INNE	30	1931-60	13.55	9.81	8.43	5.25	3.15	2.44	1.65	1.52	3.15	7.85	11.16	14.29	82.25
Forks 1E	350	1931-60	17.49	14.12	12.69	8.33	4.89	3.69	2.50	2.25	5.11	11.70	15.08	19.25	117.10
Grayland 25	15	1953-62	11.10	9.43	8.32	5.57	3.06	2.66	1.38	2.14	3.25	7.60	10.82	11.07	76.40
Grays River	50	1962-69	20.54	11.20	10.73	7.22	4.35	3.25	1.77	3.90	4.87	10.50	15.89	17.10	111.32
Long Beach 3NNE	25	1953-62	12.05	10.54	8.88	6.38	3.42	3.22	1.42	2.24	3.33	8.05	11.52	11.74	82.79
Neah Bay 1E	40	1931-62	14.55	12.01	10.74	6.64	3.96	3.22	2.52	2.03	4.06	9.60	13.40	16.43	99.16
Quinault R.S	220	1931-60	19.95	15.94	14.22	9.18	5.90	4.31	2.60	2.79	6.00	13.27	17.52	22.75	134.43
Willapa Harbor	150	1931-60	12.37	10.43	9.89	5.94	3.68	3.17	1.46	1.73	3.55	8.50	11.25	14.59	86.56
PUGET TROUGH															
Battle Ground	295	1941-60	6.96	5.53	5.26	3.46	3.02	2.58	.71	1.08	2.19	5.29	7.68	7.59	51.35
Castle Rock	43	1954-61	7.64	7.24	7.58	4.13	2.47	1.65	.76	1.32	1.99	5.64	9.15	8.84	58.41
Cathlamet 9NE	476	1931-60	12.84	10.14	9.86	6.42	3.48	2.90	1.26	1.84	3.28	8.71	12.87	15.99	89.59
Centralia	185	1931-60	6.36	5.45	4.66	2.68	1.91	1.92	.73	1.02	1.86	4.50	6.69	7.75	45.53
Elma	68	1940-62	9.43	8.49	6.89	4.50	2.46	2.08	.98	1.29	2.68	6.76	9.12	10.05	64.73
Frances	231	1941-68	11.85	9.16	6.76	4.56	4.19	2.02	.81	1.58	2.47	7.60	11.66	11.62	74.28
Longview	12	1931-60	5.81	4.87	4.85	2.72	2.30	2.14	.75	1.26	2.01	4.40	6.43	7.56	45.10
Olympia	190	1931-60	7.85	6.62	5.40	2.96	2.01	1.79	.76	.89	2.09	5.28	7.67	9.05	52.37
Vancouver	100	1931-60	5.63	4.43	4.00	2.31	2.02	1.88	.46	.74	1.64	3.58	5.64	6.67	39.00
FOOTHILLS AND WEST SLOPES CASCADES															
Cinebar 2E	1000	1940-53	10.24	8.61	6.98	4.39	3.88	4.10	1.74	1.73	4.52	7.01	10.26	11.07	74.53
Cougar 4SW	530	1941-60	16.00	13.16	11.68	6.81	4.69	3.73	1.07	1.95	4.81	10.84	15.49	18.76	108.99
Kosmos	775	1933-60	8.30	6.47	6.07	4.20	3.21	3.14	.91	1.44	3.03	6.19	8.61	10.41	62.01
Longmire R.S	2762	1931-60	10.92	8.98	8.32	5.11	4.12	3.63	1.35	1.75	3.92	8.63	11.91	13.79	82.43
Packwood	1060	1925-60	8.10	5.76	5.53	3.18	2.40	2.22	.48	.82	2.20	5.03	8.39	9.44	53.55
Randle	946	1931-60	8.38	6.98	6.36	3.98	2.97	2.75	.72	1.33	2.67	6.32	8.73	10.60	61.79
Spirit Lake	3240	1932-56	13.85	10.60	10.81	5.96	4.70	3.66	.97	1.78	3.85	8.69	12.95	15.62	93.44

Source - "Water Resources of Southwest Washington", Dept. of Ecology, 1972, P. 14.

Table 2 -- Average and Greatest Monthly and Seasonal Snowfall, in Inches, Southwestern Washington

Area/ Station	JUL	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	TOTAL
COASTAL - WEST OLYMPIC													
Aberdeen													
Average					.4	1.2	4.8	1.6	.6	4.0			8.6
Greatest					13.5	22.3	42.5	44.0	6.5				90.5
Clallam Bay 1E													
Average					.4	1.3	5.0	1.5	.3	T			8.5
Greatest					4.0	36.1	33.6	12.0	12.0	.2			37.4
Forks 1E													
Average					.6	2.9	5.6	2.6	3.5	.1			15.3
Greatest					7.5	36.0	46.6	19.2	38.5	4.0			53.0
Quinault R.S.													
Average					.2	3.0	5.6	1.8	T				11.9
Greatest					9.0	40.3	30.7	11.0	34.7	3.8			52.8
Willapa Harbor													
Average				T	.1	.4	2.8	.8	.7				4.8
Greatest				1.0	2.6	10.0	22.1	14.0	12.0	.7			25.4
PUGET TROUGH													
Centralia													
Average					.5	.4	5.0	2.2	1.1				9.2
Greatest					6.5	8.8	45.4	25.4	18.9	1.0			45.9
Longview													
Average				T	.1	.4	4.3	1.3	.5				6.6
Greatest				1.0	5.0	6.0	39.2	23.7	16.1				36.5
Olympia													
Average					1.5	2.3	7.2	2.8	2.0				15.8
Greatest					10.6	16.5	45.7	17.7	20.6				51.9
Vancouver													
Average					.2	.4	4.5	.9	.4				6.4
Greatest					4.5	18.3	35.3	15.5	5.5				45.8
FOOTHILLS AND WEST SLOPE CASCADES													
Kosmos													
Average				T	.6	2.7	10.2	4.4	2.6				20.5
Greatest				4.8	16.5	45.0	75.5	39.0	29.0	21.0			102.3
Longmire R.S.													
Average				1.4	14.4	34.0	48.4	37.6	32.2	9.0	.7	T	177.7
Greatest				12.0	70.0	115.1	151.5	123.0	131.5	49.5	19.0	.5	375.6
Packwood													
Average				.1	1.1	7.0	13.4	9.4	3.1	.2			34.3
Greatest				1.7	6.1	44.0	40.2	28.5	31.0	2.2			68.9
Paradise R.S.													
Average	.3	T	5.2	22.0	64.9	105.1	117.6	88.7	98.6	54.1	21.3	4.3	582.1
Greatest	5.0	6.0	26.0	77.2	190.0	168.0	363.0	227.5	206.0	116.1	62.0	47.5	1000.3
Randle													
Average				T	1.1	1.9	13.7	7.0	2.2	T			25.8
Greatest				6.0	13.5	23.0	95.1	50.1	20.1	3.0	.5		96.8
Spirit Lake													
Average			.1	3.2	19.6	50.0	70.7	57.5	61.1	16.7	3.7	T	282.6
Greatest			.8	20.5	72.4	129.1	163.6	152.3	114.3	67.9	30.0		492.8

Source - "Water Resources of Southwest Washington", Dept. of Ecology, 1972, P. 17.

The coldest weather occurs when the Pacific Northwest is under the influence of continental, rather than maritime, air masses. The frost free season, ranging from 150-200 days, is influenced by terrain, air drainage and distances from large bodies of water. Table 3 gives probability of freezing temperatures for 10 stations during spring and fall, and mean length of growing season. Much of the cropland of the Basin is located near Vancouver, with a growing season of 200-235 days.

Cloudiness, Sunshine and Solar Radiation

The number of clear or partly cloudy days each month varies from 3-6 in winter, 7-15 in spring and fall, and 15-20 in summer. The amount of sunshine received is approximately 20 percent in winter, 30-50 percent in spring and fall, and 50-65 percent in summer.

Wind

Prevailing winds over the eastern North Pacific at this latitude blow from southwest to west in fall and winter, shifting to west and northwest in spring and summer. The strongest winds are associated with the most intense winter storms moving east across the ocean. In winter, air circulation around the low centers approaching the coast results in a high incidence of strong southeasterly and southerly winds and strong easterly winds in the Strait of Juan de Fuca. In coastal areas, wind velocities ranging from 50-70 MPH are reported each winter. Extreme winds at 30 feet above the ground can be expected to reach 80 MPH once in 10 years and 90-100 MPH once in 100 years. On exposed ridges near the coast, wind velocities in excess of 100 MPH can be expected each winter.

Table 3. Probability of Freezing Temperatures (32° F.) Occurring in Spring and Fall, Southwestern Washington

Station	Spring			Fall			Mean Length of Growing Season (Days)
	90 Percent Chance	50 Percent Chance	10 Percent Chance	10 Percent Chance	50 Percent Chance	90 Percent Chance	
			COASTAL - WEST OLYMPIC				
Aberdeen	Mar 25	Apr 19	May 14	Oct 2	Oct 25	Nov 17	189
Forks 1E	Mar 28	Apr 22	May 18	Sep 25	Oct 18	Nov 10	179
Willapa Harbor	Mar 19	Apr 13	May 9	Oct 16	Nov 8	Dec 1	209
			PUGET TROUGH				
Battle Ground	Apr 12	May 7	Jun 2	Sep 19	Oct 12	Nov 4	158
Centralia	Mar 30	Apr 24	May 19	Sep 26	Oct 19	Nov 13	178
Longview	Apr 3	Apr 29	May 25	Sep 25	Oct 18	Nov 10	172
Olympia	Apr 14	May 7	May 29	Sep 20	Oct 14	Nov 6	160
Vancouver	Feb 28	Mar 25	Apr 20	Oct 23	Nov 15	Dec 8	235
			WEST SLOPE CASCADES				
Kosmos	Apr 18	May 13	Jun 7	Sep 8	Oct 2	Oct 25	142
Longmire R.S.	Apr 30	May 25	Jun 19	Sep 8	Oct 1	Oct 24	129

SOURCE: "Water Resources of Southwest Washington," Dept. of Ecology, 1972, P. 22.

VEGETATION

The vegetation of Western Washington reflects the transition from alpine areas on mountain peaks to the seashores. A broad perspective of the vegetative resource shows several distinct types, described as follows:

Most of the basin is heavily forested. Tree species vary with changes in soils, elevation, and rainfall. Douglas-fir is the most important timber tree and grows extensively on well-drained soils. Other important forest types are: (1) true fir--mountain hemlock association in the highlands; (2) Pacific silver fir--western hemlock type, associated with Douglas-fir in mid-and lower-elevations on well drained soils; (3) sitka spruce-western red cedar type found on poorly drained soils along the coast. Red alder and other deciduous species are common along streams and on cutover or burned lands which have not been reforested with conifers.

The understory or ground cover consists of a variety of plants, including salal, salmonberry, huckleberry, snowberry, thimbleberry, and associated ferns and mosses. Blackberry and fireweed and bracken fern are common invaders on logged, burned or cleared land. Sword fern is common in moist, shady areas. The more common shrubs are elderberry, serviceberry, and devil's club.

Prairie-like areas occur throughout the central portions of the Basin and in portions of Clark County. Grass is the dominant vegetation, but moss, lichens, and ferns are also found. The principal grasses are ticklegrass and meadow fescue. Scotch broom has now invaded parts of open areas.

Adjacent to many lower-elevation streams and rivers and more level upland terraces, man, through farming, has altered the natural vegetative cover. Cropland, pasture, and hay land, and small areas of specialty crops and orchards are fingered into the extensive forest lands. Here, too, man has covered some of the area with the concrete and rooftops of his towns and cities.

Salt water marshes have a salt grass cover, while fresh water marshes and bogs commonly have a cover of sedges, rushes, tufted hair grass, and forbs. On the alluvial flood plains or bottom lands, vegetative cover varies with the degree of soil drainage.

Typical of many acres of forest land in the Olympic Subbasin of Southwestern Washington is this productive forest type in the Quinault rain forest (Washington State Travel Division photo).

LAND RESOURCES

Soils

Soil, the surface mantle of the earth penetrated by roots and water, is basic to life because it is the source for growing food and fiber. It serves as a storage reservoir for plant food and water. A silt loam, considered a representative surface soil, contains approximately 50 percent solids and 50 percent pore space. The pore space is less for sandy soils and greater for clayey soils. The 50 percent solid space is about 45 percent mineral and 5 percent organic. At optimum moisture for plant growth, the 50 percent pore space is about 30 percent water and 20 percent air.

Subsoil is likely to be more compact and less pervious to air and water than surface soil. Therefore, subsoil generally has a higher percentage of minerals and a lower content of organic matter, water and air. Air and water content of soils are interrelated and the relative amounts are continually changing. The nature and distribution of soils depend on climate, vegetation, parent material, topography, and time. The interaction among these factors results in a soil having a unique set of properties. In most cases, factors are interdependent and not necessarily balanced; for example, an abrupt change in topography may cause climatic changes, resulting in a difference of vegetation, which, in turn, influences the soil. Topographic positions compared with geologic formations may indicate the age of soil or kind of soil parent material. Factors such as high water tables can be inferred from soil properties. Soil properties are the basis for classifying soil series. Soil associations, as shown by the general soil map (Figure 3), are combinations of soil series occurring naturally on the landscape.

Soil associations have been further aggregated into six general groups as they occur in the Southwestern Washington River Basin area. These broad groupings are illustrated by the general soil map. The relative importance of each group of soil association is as follows:

Soil Association Group	Estimated Acreages	Percent of Basin
A	1,712,900	24.4
B	77,200	1.1
C	659,900	9.4
D	603,700	8.6
E	3,208,265	45.7
F	758,200	10.8
TOTAL	7,020,165	100.0

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M7-E-2321-N

Group A – This group covers nearly one-fourth of the Southwestern Washington Basin and consists of steep and very steep well drained mountainous soils. The dominant vegetation is forest with some alpine areas. The A1 and A3 associations consist of shallow to deep loamy soils formed in volcanic ash, glacial materials and weathered parent rock. They receive 70-180 inches annual precipitation. The A2 association comprises rock outcrops and shallow loamy soils formed in colluvium and volcanic materials. This association is above timberline with 120-140 inches annual precipitation.

Group B – This group is very limited and occupies only about 1 percent of the Basin. Dominant vegetation is grass. Soils of this group are deep, sandy, somewhat poorly drained, and formed in wind and water-laid deposits. It is located along the coastal beaches and formed under 55-70 inches annual precipitation.

Group C – This group occupies gently sloping to steep glacial plains, terraces, and foothills. It constitutes about 9 percent of the Basin and is dominantly forested. Annual precipitation progresses from 13-35 inches for the C1 soil association to 40-80 inches for the C5 association. The soils in this group are moderately deep and deep. Soils in the C3 and C5 associations are well to somewhat poorly drained, and the C1, C2 and C4 association soils are somewhat excessively to somewhat poorly drained. The soils in associations C1, C2, C3 and C4 formed in volcanic ash, pumice, glacial materials, and alluvium. C5 soils formed in old alluvium, shale and sandstone. Soils in the C2 and C5 associations are loamy; soils in C1 are sandy and loamy; C3 soils are loamy (many are gravelly); and C4 soils are loamy and clayey.

Group D – This group of associations makes up less than 9 percent of the Basin. Although dominantly forested, much of the cultivated land and urban development is located on soils of this group. The associations of this group are nearly-level to gently sloping soils on alluvial lands. The D1 association consists of deep, well to somewhat poorly drained loamy soils formed in alluvium and glacial material under 80-160 inches of annual precipitation. Excessive precipitation is a limiting factor for cultivation or urban use. The D2, D3 and D4 associations are deep soils with annual precipitation varying from 40-90 inches. Associations D2 and D4 are well to somewhat poorly drained loamy and clayey soils formed in alluvium. Association D3 is somewhat excessively and well drained sandy and loamy soils, also formed in alluvium. On the map (Figure 3) alluvial lands have been generalized as far as actual area is concerned, in order to emphasize these often very narrow flood plains.

Group E – Over 3.2 million acres, or about 46 percent of the entire Southwestern Washington Basin, consists of this group of associations. Vegetation is dominantly forest. The associations are moderately steep to very steep soils on mountain foothills and footslopes. These soils developed under annual precipitation rates varying from 35-150 inches. The E1, E4, E5, E6 and E7 associations are deep loamy and clayey soils. The soils are well drained except that some E6 soils are somewhat excessively drained. The E2 association is moderately deep and deep well drained clayey soils. The E3 association is moderately deep and deep, well to somewhat poorly drained gravelly loamy soils. Soils in association E1 formed in glacial materials, parent rock, some marine clays, volcanic ash and pumice. Soils in other associations formed in the following material:

E2 - Weathered parent material
E3 - Glacial outwash and till
E4 - Weathered parent rock and alluvium
E5 - Weathered parent rock and volcanic ash
E6 - Weathered parent rock, volcanic ash and pumice
E7 - Weathered parent rock and volcanic ash

Group F – This group of associations constitutes about 11 percent or more than 758,000 acres of the basin. The associations are nearly level to strongly sloping soils on terraces, foothills and valleys. The dominant vegetation is forest, although associations F4 and F5 contain significant amounts of cropland.

The soils in this group are moderately deep and deep. They formed under 35-100 inches of annual precipitation. The soils are well to somewhat poorly drained, except that association F5 soils are well drained. F1, F3 and F4 associations are loamy and clayey soils formed in alluvium. The F2 association clayey soils formed in parent rock, pumice and volcanic ash. F5 is loamy soils, some of which are gravelly, formed in alluvium.

Land Capability

An interpretive grouping of soils into land capability classes for agriculture has been developed by the Soil Conservation Service. This classification relates soil properties, behavior, and response to agricultural uses. Soil properties such as depth, texture, wetness, slope, erosion hazard, overflow hazard, permeability, structure, reaction, water-holding capacity, inherent fertility, and climatic conditions as they influence safe use and management of land are considered in grouping soils into eight land capability classes. Definitions of these eight classes designated by Roman numerals as indicated on the general land capability map [3/] (Figure 4) follow:

3/ General land capability map was derived from soils mapping prior to 1970. Class I is not shown on the map.

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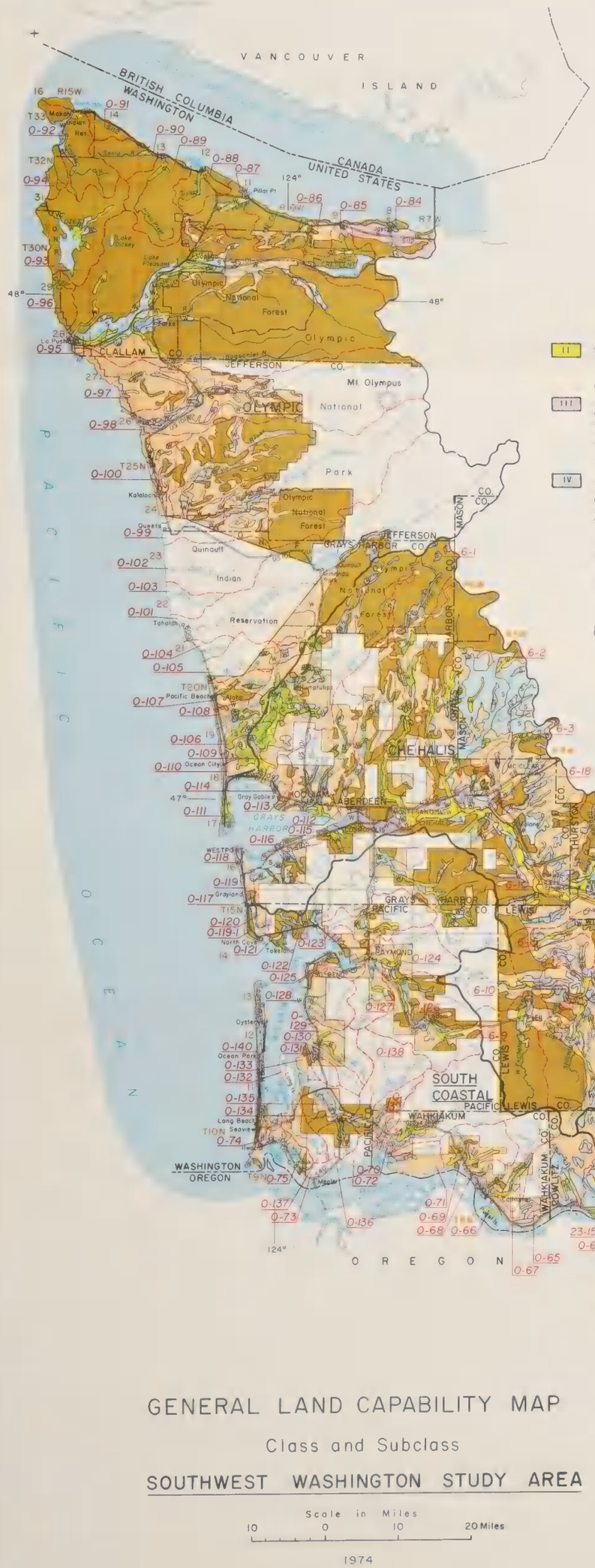


BASINS

OLYMPIC

CHEHALIS

SOUTH COASTAL

COWLITZ

LEWIS

LOCATION MAP

LEGEND

LAND SUITED FOR CULTIVATION AND OTHER USES

II — Soils in Class II have some limitations that reduce the choice of plants, or require moderate conservation practices. The soils are well suited for cultivated crops, pasture, woodland, wildlife food and cover, and recreation.

III — Soils in Class III have severe limitations that reduce the choice of plants, or require special conservation practices. When used for cultivated crops, the conservation practices are usually more difficult to apply and to maintain. The soils are suited for cultivated crops, pasture, woodland, wildlife food and cover, and recreation.

IV — Soils in Class IV have very severe limitations that restrict the choice of plants, require very careful management, or both. The soils in Class IV may be used for crops, pasture, woodland, wildlife food and cover, and recreation.

SUBCLASSES

e-Potential erosion or past erosion damage, sediment source. (Undesignated delineations are Subclass e)

w-Wetness, poor drainage or overflow.

s-Shallow, stony or low moisture-holding capacity soils.

(W) Subclass boundary and symbol

LAND LIMITED IN USE GENERALLY NOT SUITED FOR CULTIVATION

V — Soils in Class V have little or no erosion hazard but have other limitations impractical to remove that limit their use largely to pasture, range, woodland, or wildlife food and cover.

VI — Soils in Class VI have severe limitations that make them generally unsuited for cultivation and limit their use largely to pasture or range, woodland, wildlife food and cover, and recreation.

VII — Soils in Class VII have very severe limitations that make them unsuited for cultivation and that restrict their use largely to grazing, woodland, wildlife, recreation, and water supply.

VIII — Soils and land forms in Class VIII have limitations that preclude their use for commercial plant production and restrict their use to recreation, wildlife, water supply, or esthetic purposes.

Unclassified-Not soil surveyed.

LEGEND

STUDY AREA BOUNDARY

BASIN BOUNDARY

0-84 WATERSHED NUMBER & BOUNDARY

INDIAN RESERVATIONS, NATIONAL PARKS AND NATIONAL FOREST BOUNDARIES

TOWNSHIP & RANGE LINES

LAKES & RESERVOIRS

SMALL RIVERS & STREAMS

SALT WATER & LARGE RIVERS

GENERAL LAND CAPABILITY MAP

Class and Subclass

SOUTHWEST WASHINGTON STUDY AREA

Scale in Miles

10 0 10 20 Miles

1974

FIGURE 4

M7-E-23211-N

Class I - Soils having few or no limitations or hazards. They may be used safely for cultivated crops, pasture, range, woodland, or wildlife.

Class II - Soils having few limitations or hazards. Simple conservation practices are needed when cultivated. They are suited to cultivated crops, pasture, range, woodland, or wildlife.

Class III - Soils requiring more difficult or complex conservation practices when cultivated. They have more limitations and hazards than those in Class II. They are suited to cultivated crops, pasture, range, woodland, or wildlife.

Class IV - Soils requiring still more difficult or complex measures when cultivated. They have greater limitations and hazards than Class III soils. They are suited to cultivated crops, pasture, range, woodland, or wildlife.

Class V - Soils having little or no erosion hazard, but having other limitations that prevent normal tillage for cultivated crops. They may be suited to pasture, range, woodland, or wildlife.

Class VI - Soils having severe limitations or hazards that make them generally unsuited for cultivation. They are generally suited to pasture, range, woodland, or wildlife.

Class VII - Soils having very severe limitations or hazards that make them generally unsuited for cultivation or pasture. They may be suited for grazing, woodland, or wildlife.

Class VIII - Soils and landforms having limitations and hazards that prevent their use for cultivated crops, pasture, range, or woodland. They may be suited for recreation, wildlife, or water supply.

Two groups of capability classes are significant: (1) land in capability classes I through IV is suited for cultivation and other uses, and (2) land in capability Classes V through VII is best suited for natural vegetation including grass and forest, which provide grazing and wood products as well as habitat for wildlife. Class VIII land is generally unproductive from the standpoint of vegetation but is useful for recreation, wildlife and water supply.

Land capability classes are divided into four subclasses indicating kinds of limitations within classes. Many soils have more than one limitation influencing their use. The subclasses are designated by letters e, w, s and c. Subclass c areas were too small to delineate on the map (Figure 4).

Definitions of subclasses follow:

Subclass e - Soils having susceptibility to erosion damage as the dominant problem or hazard of their use.

Subclass w - Soils having poor drainage, wetness, high water table, or overflow as the dominant hazard or limitation of their use.

Subclass s - Soils having shallow depths, stones, low moisture-holding capacity, low fertility difficult to correct, and salinity or alkalinity within the root zone as the dominant hazard or limitation of their use.

Subclass c - Soils having the climate (temperature or lack of moisture) as the only major hazard or limitation of their use.

The relative areal importance of land capability classes and subclasses in Southwestern Washington is shown by the following tabulation.

Class	Acres	Percent of Area
II	279,038	4.0
III	474,200	6.8
IV	606,366	8.6
Subtotal	1,359,604	19.4
V	56,732	0.8
VI	3,178,933	45.3
VII	2,192,519	31.2
VIII	232,377	
Subtotal	5,660,561	80.6
Total	7,020,165	100.0

Subclass	Acres	Percent of Area
e	5,961,713	84.9
s	275,229	3.9
w	752,821	10.7
c	30,402	0.5
Total	7,020,165	100.0

It is significant to note that irrespective of present land use less than 20 percent of Basin lands have potential for agriculture (Class I-IV). Erosion hazard is the dominant limitation affecting nearly 85 percent of the lands in Southwestern Washington.

Table 4, page displays land capability class and subclass in relation to nine broad categories of land use for Southwestern Washington.

Land uses are defined on pages 23-30.

Table 4 .--Land Use by Land Capability Class and Subclass, Southwestern Washington - 1969

Land Use	II					III				IV				II - IV Inclusive
	LAND CAPABILITY CLASS													
	Land Capability Subclasses													
	c	e	s	w	Sub-total	e	s	w	Sub-total	e	s	w	Sub-total	
Commercial Forest.....	1,777	46,564	1,373	67,261	116,975	206,209	5,171	78,666	290,046	297,003	86,832	78,444	462,279	869,300
Noncommercial Forest...	-	-	-	-	-	20	-	-	20	-	-	-	-	20
Reserved Prod. Forest..	-	-	-	661	661	30	-	4,360	4,390	1,172	3,197	70	4,439	9,490
Cropland.....	5,875	32,592	198	78,633	117,298	72,134	4,084	55,924	132,142	21,211	21,405	35,124	77,740	327,180
Pasture.....	242	2,146	110	8,962	11,460	8,144	526	4,849	13,519	7,590	12,886	5,923	26,399	51,378
Rural Nonfarm.....	1,195	5,006	10	2,263	8,474	7,979	180	3,383	11,542	3,107	2,926	2,489	8,522	28,538
Built-Up Lands.....	2,782	6,097	40	13,309	22,228	14,355	1,329	5,329	21,013	5,715	11,249	8.125	25,089	68,330
Barren Lands.....	-	20	-	1,566	1,586	39	-	1,111	1,150	301	120	1,169	1,590	4,326
"Other" Lands.....	-	90	-	253	343	190	-	200	390	69	160	97	326	1,059
TOTAL.....	11,871	92,515	,731	172,908	279,025	309,100	11,290	153,822	474,212	336,168	138,775	131,441	606,384	1,359,621
PERCENT (II-IV inc.).....	20.5						34.9						44.6	19.4 (Southwest) (Washington)

	V			VI				VII				VIII					V - VIII Inclusive
	s	w	Sub-total	e	s	w	Sub-total	e	s	w	Sub-total	c	e	s	w	Sub-total	
Commercial Forest.....	27,866	13,620	41,486	2,440,682	40,241	149,809	2,630,732	1,901,091	13,017	7,362	1,921,470	40	41,207	5,046	24,584	70,977	4,664,665
Noncommercial Forest...	30	-	30	128,327	-	608	128,935	94,472	4,103	-	98,575	2,242	38,584	4,677	4,192	49,695	277,235
Reserved Prod. Forest..	-	-	-	268,795	852	1,974	271,621	138,430	149	-	138,579	50	4,034	680	1,413	6,177	416,377
Cropland.....	1,457	5,328	6,785	21,529	5,137	6,825	33,491	6,159	327	388	6,874	-	-	50	1,673	1,723	48,873
Pasture.....	458	60	518	11,773	1,525	4,006	17,304	2,322	690	20	3,032	-	2,610	-	2,144	4,754	25,608
Rural Nonfarm.....	480	552	1,032	3,837	599	1,521	5,957	906	469	-	1,375	-	345	-	325	670	9,034
Built-Up Lands.....	6,421	260	6,681	10,408	2,165	6,948	19,521	4,349	2,318	100	6,767	-	3,296	50	2,026	5,372	38,341
Barren Lands.....	130	-	130	67,227	903	1,770	69,900	11,972	1,790	269	14,031	16,100	16,943	329	4,736	38,108	122,169
"Other" Lands.....	70	-	70	1,058	60	326	1,444	1,310	509	-	1,819	-	2,269	848	51,792	54,909	58,242
TOTAL.....	36,912	19,820	56,732	2,953,636	51,482	173,787	3,178,905	2,161,011	23,372	8,139	2,192,522	18,532	109,288	11,680	92,895	232,385	5,660,544
PERCENT (V-VIII inc.)			1.0				56.2				38.7					4.1	80.6 (Southwest) (Washington)

Source: River Basin Planning Staff

Land Use and Ownership

Land use has been separated into nine categories: commercial forest, noncommercial forest, reserved forest, cropland, pasture, rural nonfarm, built-up, barren, and "other" land. Table 5 and accompanying diagram give land use and water area for Southwestern Washington, and Figure 5 shows the distribution. 4/

The Southwestern Washington Basin contains nearly 7.5 million acres with 43 percent in public ownership and 57 percent in private ownership. Public ownership is divided about equally between the State of Washington and the Federal Government. State-owned lands, about 1.3 million acres, are mostly in forest and are administered by the Washington State Department of Natural Resources throughout all five subbasins. Only a small acreage is in state parks. Federally-owned lands include nearly 1.3 million acres in the Olympic and Gifford Pinchot National Forests and over 580,000 acres in Olympic National Park; a small portion of Mount Rainier National Park, and Fort Vancouver National Historic Site. County and local governments account for only 1 percent of land ownership.

Most private lands, nearly 2.5 million acres, are in large corporate holdings, such as the Weyerhaeuser Company, Crown Zellerbach, ITT-Rayonier, and other timber owners. Remaining private lands, almost 1.8 million acres, are owned mostly by individuals, corporations and partnerships, in farms, woodlots, cities and rural areas. A small portion of this private ownership, about 230,000 acres, is Indian land on the Quinault Indian Reservation and smaller reservations. The acreage includes both tribally-owned lands and allotted lands under management of the Bureau of Indian Affairs.

4/ Generalized land use map was derived from the 1969-70 land use data interpreted from aerial photographs, with local assistance and on-site inspection.

U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

BASINS

- OLYMPIC
- CHEHALIS
- SOUTH COASTAL
- COWLITZ
- LEWIS

LAND USE LEGEND

- Built up
- Rural non-farm
- Cropland
- Pasture
- Commercial forest
- Non-commercial forest
- Reserve productive forest lands
- Barrens
- Land use boundary

LOCATION MAP

LEGEND

- STUDY AREA BOUNDARY
- BASIN BOUNDARY
- 0-84 WATERSHED NUMBER & BOUNDARY
- INDIAN RESERVATIONS, NATIONAL PARKS AND NATIONAL FOREST BOUNDARIES
- TOWNSHIP & RANGE LINES
- LAKES & RESERVOIRS
- SMALL RIVERS & STREAMS
- SALT WATER & LARGE RIVERS

GENERALIZED LAND USE MAP
SOUTHWEST WASHINGTON STUDY AREA

Scale in Miles
10 0 10 20 Miles

1974

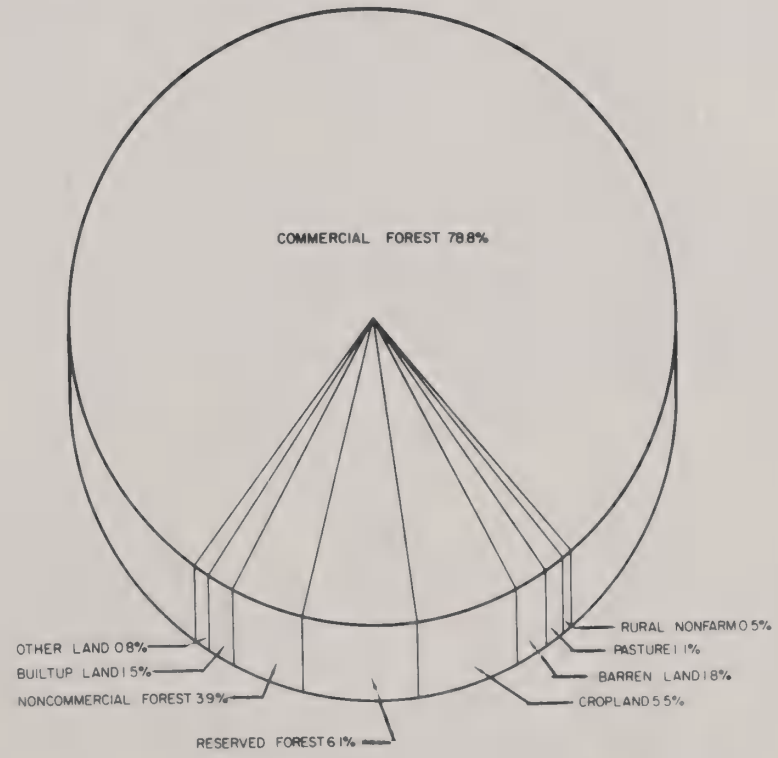
FIGURE 5

M7-E-2321-N

Table 5. Present Land Use and Water Area, Southwestern Washington - 1969

Land Use	Acres	Percent of Total
Commercial Forest	5,533,965	78.8
Noncommercial Forest	277,255	3.9
Reserved Forest	425,867	6.1
Cropland	376,053	5.5
Pasture	76.986	1.1
Rural Nonfarm	37,572	0.5
Built-Up Lands	106,671	1.5
Barren Lands	126,495	1.8
Other Lands	59,301	0.8
Total Land Area	7,020,165	100.0
Fresh Water	109,542	23.0
Salt Water	367,393	77.0
Total Water Area	476,935	100.0
Total (Land and Water) Area	7,497,100	

Source: River Basin Planning Staff .



This information is shown in more detail in Table 6, "Land Use by Land Ownership for Southwestern Washington," and Figure 6, "Generalized Land Ownership."

Forest Lands - Forests cover over 6.2 million acres, or nearly 88 percent, of Southwestern Washington. These forests cover all but agricultural bottom lands along major rivers and streams. Some non-forest barren areas exist along ridges on the eastern boundary. Forest lands are the major source of Basin runoff, and form the land base for the leading industry of the State.

Three broad categories of forest land comprise the principal land use of Southwestern Washington. They are defined as follows:

> Commercial forest land - Forest land which is producing, or is capable of producing, crops of industrial wood and is not withdrawn from timber utilization by statute or administrative regulation.
>
> Non-commercial forest land - Forest land incapable of yielding crops of industrial wood products (usually saw timber) because of adverse site conditions.
>
> Reserved forest land - Public forest land withdrawn from timber utilization through statute or administrative order. Examples include national parks and national forest wilderness areas.

Of the forested area, nearly 5.6 million acres are classed as commercial forest land, and support over 132 billion board feet of standing timber. This amounts to 29 percent of the State's commercial forest area and 38 percent of its sawtimber volume.

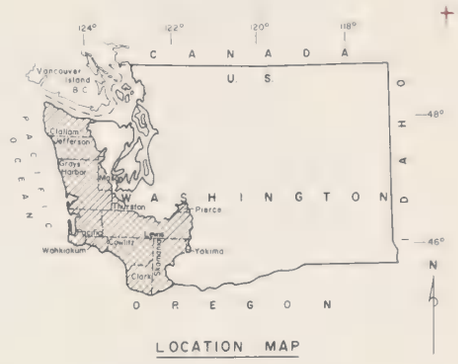
Of the 600,000 acres classed as noncommercial forest land, nearly 400,000 acres are of commercial character but are in areas reserved from timber harvest. These include Olympic and Mount Rainier National Parks, Mount Adams and Goat Rock Wilderness, state and local parks, and other special management areas. The remaining 200,000 acres are unsuitable for growing commercial timber crops because of their low productivity or inaccessibility.

Table 6. Land Use by Land Ownership, Southwestern Washington - 1969.

Land Use	National Forest	National Park	Other Federal	Corporate	City & County	Private	State	Indian Lands	Total
	Acres								
Commercial Forest.....	1,063,085	-	7,881	2,427,596	56,517	955,403	803,678	219,456	5,533,616
Noncommercial Forest....	137,372	133,789	-	5,623	-	381	90	-	277,255
Reserve Productive Forest.....	40,090	378,810	150	1,042	10	5,271	843	-	426,216
Cropland.....	20	-	291	10,893	518	359,051	3,885	1,395	376,053
Pasture.....	20	170	134	15,104	109	53,335	6,683	1,431	76,986
Rural Nonfarm.....	50	71	29	995	138	35,889	130	270	35,572
Built-Up Lands.....	90	80	637	9,172	10,249	71,828	13,905	710	106,671
Barren Lands.....	45,468	66,694	370	6,652	299	5,651	990	371	126,495
"Other" Lands.....	-	2,145	711	2,352	1,908	15,547	34,942	1,701	59,306
TOTAL.....	1,286,195	581,759	10,203	2,479,429	69,748	1,502,336	865,146	225,334	7,020,170

Source: River Basin Planning Staff.

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE



LOCATION MAP

BASINS

OLYMPIC

CHEHALIS

SOUTH COASTAL

COWLITZ

LEWIS

PRIVATE
CORPORATE
STATE
MUNICIPAL & COUNTY
INDIAN LANDS
NATIONAL FOREST
NATIONAL PARK & OTHER FEDERAL

LEGEND

STUDY AREA BOUNDARY

BASIN BOUNDARY

0-84 WATERSHED NUMBER & BOUNDARY

INDIAN RESERVATIONS, NATIONAL PARKS AND NATIONAL FOREST BOUNDARIES

TOWNSHIP & LINES

LAKES & RESERVOIRS

SMALL RIVERS & STREAMS

SALT WATER & LARGE RIVERS

GENERALIZED LAND OWNERSHIP

SOUTHWEST WASHINGTON STUDY AREA

Scale in Miles
10 0 10 20 Miles

1974

FIGURE 6

M7-E-2321-N

About 2.6 million forested acres, or 43 percent, are in public ownership. Of this 18 percent is national forest, and 13 percent is state-owned. The 12 percent balance is in national parks, county forest or Indian Reservations. Fifty-seven percent, or over 3.5 million acres, is privately owned. Three-quarters of this acreage is in large industrial tree farms. The diagram below illustrates the relative distribution of land ownership.

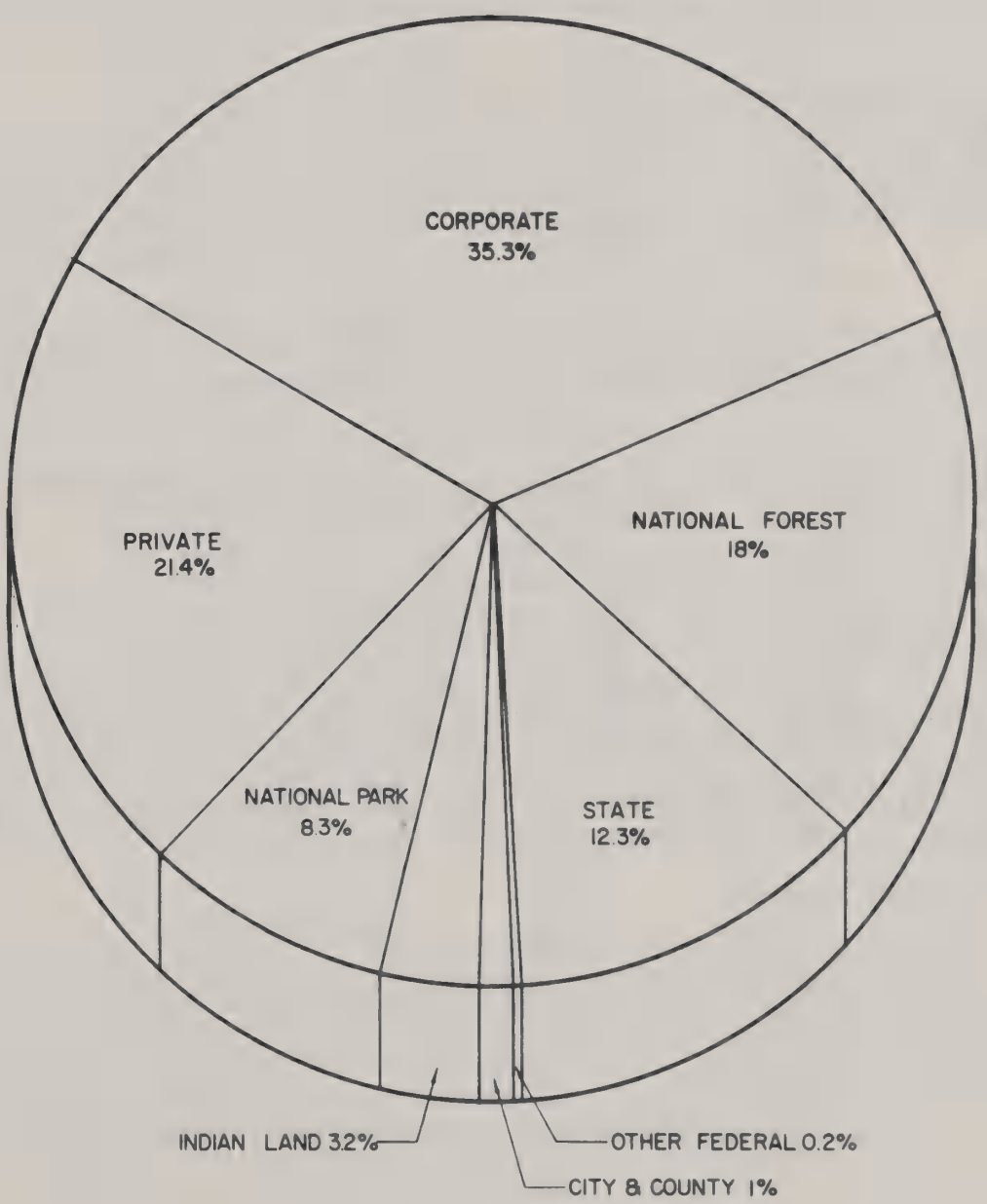


Table 7. Area of Commercial Forest Land by Species, Stand Size and Ownership Southwestern Washington

Species	Public (1000 Ac)	Public (Percent)	Private (1000 Ac)	Private (Percent)
Douglas-fir	917	16	2,505	45
Hemlock-Sitka Spruce	579	11	963	17
True fir-spruce	381	7	92	2
Ponderosa pine	3	-	-	-
White Pine	20	-	1	-
Lodgepole pine	22	1	3	-
Hardwoods	10	-	38	1
Sub-total	1,932	35	3,602	65

Total ..... 5,534 Thousand Acres 100 percent

Stand Size	Public (1000 Ac)	Public (Percent)	Private (1000 Ac)	Private (Percent)
Sawtimber	1,375	25	1,804	33
Poletimber	279	5	677	12
Seedlings and Saplings	222	4	1,010	18
Non-stocked	56	1	111	2
Sub-total	1,932	35	3,602	65

Total ..... 5,534 Thousand Acres 100 percent

Source - U.S. Forest Service.

The public forest lands support 37 percent of the commercial timber stands in the Basin. The Olympic and Gifford Pinchot National Forests and State of Washington lands make up the bulk of this ownership--national forests encompass 19 percent, and state lands 14 percent. The Olympic and Mount Rainier National Parks contain 8 percent of the total forest land, but none is classed as commercial. The balance is made up of Indian and local government holdings. (See Table 6).

Nearly 1.5 million acres (27 percent) support old-growth or sawtimber-size regrowth. The remaining half-million acres (9 percent) are in poletimber, seedlings-and saplings-size classes. Only 1 percent is non-stocked (Table 7).

Major softwood species include Douglas-fir, western hemlock, western redcedar, and Sitka spruce along the coast and foothills, and true firs in the upper elevations. Pine types are found in the southeastern part of the region southwest of Mount Adams, and along the Columbia River (Table 7). Hardwood species of commercial importance include red alder, cottonwood, and big leaf maple.

About 45,000 acres of commercial forest land receive some grazing use by domestic livestock. This is mostly in areas adjacent to timber harvest patches where grasses and forbs develop prior to the closing of the timber canopy. These lands have an animal grazing capacity of about 7,500 AUM's.

Although timber production is one of the major uses of public forests, these lands serve many other purposes. The Olympic and Mount Rainier National Parks are giant forest reserves where vast areas of old-growth timber have been set aside, untouched, for the enjoyment of future generations. These areas include excellent examples of the Pacific Rain Forest, and are the location of the world's record largest Douglas-fir, western red-cedar and Sitka spruce. Less conspicuous but equally important types of forest vegetation have been accorded protection through Research Natural Area classification. With guidance of the Pacific Northwest Research Natural Area Committee, an interagency group organized by the Forest Service, cooperating agencies have established 12 such areas as ecological landmarks, protecting specific plant communities for future scientific studies.

There are over 80,000 acres of designated Wilderness in the Basin. These include representative timber types in high alpine areas where sub-alpine timber, meadows and unique stands of old-growth mountain hemlock and Alaska yellow-cedar exist. An additional 57,000 acres have been identified by the Chief of the Forest Service for study as potential additions to the National Wilderness System (Figure 7. These are representative of extensive areas of Southwestern Washington where the natural environment is dominant.

Another 13,300 acres of public lands principally in the State and Federal recreation systems have been specially developed for public recreation use. These include campgrounds, picnic areas, and other sites developed for intensive occupancy use.

The importance of the forested areas to recreation is emphasized by the amount of use these areas receive. In 1965, recreation use exceeded 8 million visits.

Private forest lands support 63 percent of the commercial timber in the area. About 1.7 million acres (31 percent) support stands of saw-timber size. Another 1.7 million (30 percent) acres are in poletimber, seedling and sapling size, and only 2 percent are nonstocked (Table 7).

These private lands are some of the most productive in the State. Yields of over 120 cubic feet per acre per year are not uncommon. About 70 percent of these lands are owned by the forest products industry and are receiving high levels of modern forest management. Major species include Douglas-fir, western hemlock and western redcedar in the foothills, and true firs at intermediate elevations.

About 75,000 acres, mostly in the forested foothills adjacent to farming enterprises are grazed by domestic livestock. Annual use is slightly over 15,000 AUM's.

Private forest lands provide a substantial base for the State's recreation industry. The forest industry has developed 14 improved recreation sites in the study area, and their timber access roads open large areas to hunting and fishing.

Cropland - The second major land use is cropland, yet it constitutes only 5.5 percent of the total land area. Less than 20 percent of Basin lands is suited to any type of agricultural use. Most cropland is concentrated in two locations--the Chehalis subbasin along the Chehalis River and its larger tributaries, and the Lewis subbasin, principally in southern Clark County. Together, the two subbasins account for nearly 70 percent of the cropland in the Basin; the Cowlitz and South Coastal subbasins accounting for approximately 28 percent, and the Olympic, 2 percent.

Principal crops include seeded pasture and hay, silage, and small grains. Other crops grown in the area include vegetables, berries, fruits and nuts, field crops, and nursery products. Cropping patterns are discussed in more detail in the section on Economic Development.

Of the more than 375,000 acres of cropland, only about 30,000 acres are irrigated at the present time. More than 80 percent of the irrigated acres are found in the Chehalis and Lewis subbasins.

Pasture – Approximately 75,000 acres, or 1 percent of the total area, is classified as pasture. Most of the pasture is located near the principal cropland areas in the Chehalis River drainage and in southern Clark County. It includes brush pasture and other native pasture, but excludes seeded tame pastures and haylands.

Rural Nonfarm – Land that has less than four houses per 10 acres, including farmsteads, is classified as rural nonfarm. Most acreage in this category is located close to the larger urban areas, such as Vancouver, Kelso-Longview, and Centralia-Chehalis. Smaller acreages are found along tributaries of the major rivers. Only about 0.5 percent of the total area is utilized in this way.

Built-up Land – Built-up land includes railroads, roads, airports, and all cities, towns, villages, and surrounding areas where there are four or more houses per acre. Cities of 5,000 population and over include Vancouver, 43,400; Longview, 28,400; Aberdeen, 18,500; Hoquiam, 10,430; Kelso, 10,300; Centralia, 10,207; Camas, 5,825; and Chehalis, 5,727. Built-up land comprises about 1.5 percent of the total area.

Barren Land – Less than 2 percent of the Southwestern Washington Basin is in the category of barren land. This includes the peaks of Mount Olympus and Mount St. Helens, and portions of Mount Rainier and Mount Adams.

Other Land – The "other" category includes all types of land use not given a separate heading, for example, mines, gravel pits, beach lands, and tidal lands. This category is not specifically outlined on the land use map (Figure 5), because it is interspersed with other land uses in tracts too small to display.

Snowpacks at higher elevations in Southwestern Washington serve as a reservoir feeding streams during the low rainfall summer season.

WATER RESOURCES 5/

Surface Water

Runoff – Southwestern Washington is rich in surface-water resources as measured by mean annual runoff. The mean annual runoff from the nearly 11,000-square-mile area is 73 inches, or 42,600,000 acre feet. This is at least seven times the mean annual runoff for the conterminous United States (less than 10 inches per year) and is about 45 percent of the mean annual runoff from the State of Washington (about 95 million acre-feet per year).

Even though the total water supply is large, water may not be available where and when it is needed to meet existing and future requirements. Rather large differences in average runoff from the inventory areas are evident from the data in Table 8. The Cowlitz subarea, for example, with an average annual runoff of 56 inches, has approximately half of the 105 inches normally discharged from Olympic Peninsula streams.

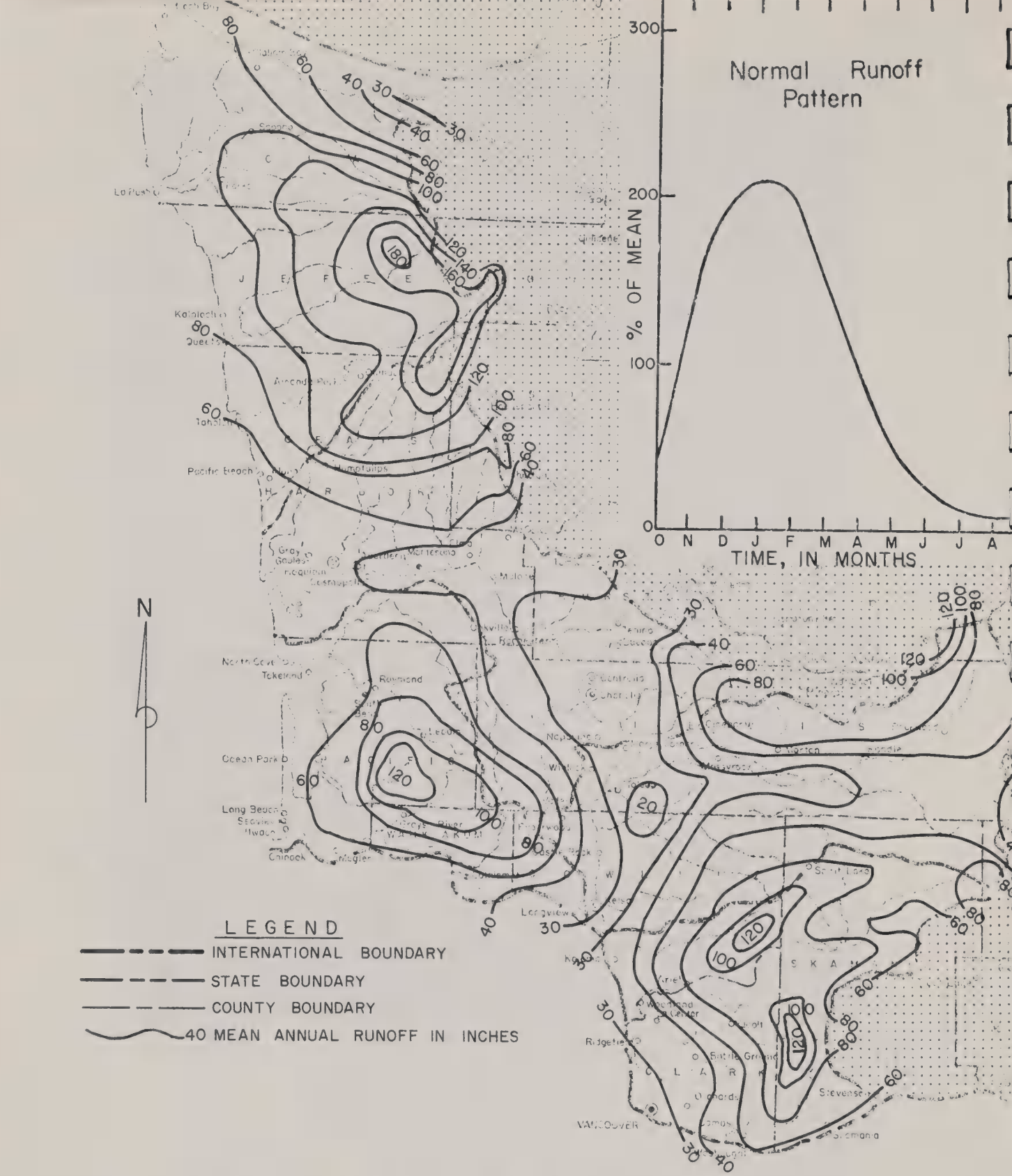
The estimated distribution of mean annual runoff (Map P. 33) shows a range from 20-30 inches in some lowlands to 180 inches in the Olympic Mountains. Runoff from the uplands of many stream basins averages 120 inches per year. Ratios of maximum to minimum annual flows averaged 2.4 and ranged from 1.7-2.9, which indicates a relatively small and uniform variation in annual mean flows of streams in Southwestern Washington. Streamflows, however, are distributed seasonally so that there are periods of high flow when flooding may occur and periods of low flow when supply may not be sufficient to meet the needs of users.

Eighty percent of the annual precipitation falls in the six months October through March. Total precipitation for July and August is less than 5 percent of the annual. Streamflow pattern follows the precipitation pattern. Normal streamflow variation is shown by the insert graph page 33.

Table 8. Estimated Average Runoffs From Water Resource Areas of Southwestern Washington.

Water Resources Area Name	Drainage Area (1,000 acres)	Runoff (inches)	Runoff (million acre-feet)
Olympic	1,759	105	15.4
Chehalis	1,670	57	8.0
South Coastal	887	72	5.3
Cowlitz	1,596	56	7.4
Lewis	1,140	68	6.5
Total Southwestern Washington	7,052	73	42.6

5/ Adapted from "Water Resources of Southwest Washington," Dept. of Ecology, June 1972.



MEAN ANNUAL RUNOFF

RIVER BASINS STUDY

SOUTHWESTERN WASHINGTON

10 0 10 20 MILES

SCALE 1:1,500,000

Major sources of fresh water in the Basin include Cowlitz and Lewis Rivers[6] in the south, Chehalis River in the central portion, and Queets River in the north. The major bodies of salt water are Grays Harbor in western Grays Harbor County, and Willapa Bay, directly south of Grays Harbor in Pacific County.

The Cowlitz River, in terms of drainage area and acre-feet of runoff, is the largest river in Southwestern Washington. Its headwaters begin on the east side of Mount Rainier in Pierce County. The river flows in a westerly direction across Lewis County until it reaches Toledo, and then swings south through Cowlitz County before discharging into the Columbia River just south of Kelso. The Cowlitz drains 2,238 square miles, with an average discharge of 6,626,000 acre-feet per year. Its maximum discharge was 139,000 cfs on December 23, 1933, and its minimum discharge was 998 cfs on November 7, 1935. Mossyrock and Mayfield Dams, built by the city of Tacoma for power production, help regulate floodflows on the Cowlitz River.

Chehalis River begins in southwestern Lewis County, and flows north through the Chehalis-Centralia area and west through the Montesano-Aberdeen area before emptying into Grays Harbor. The Chehalis drains 1,898 square miles, with an average discharge of 6,032,000 acre-feet per year. Its maximum discharge would be 115,000 cfs[7]. Its minimum discharge was approximately 535 cfs in September 1944. There are small diversions for irrigation and domestic use. No regulation exists on the Chehalis River.

Lewis River originates on the west side of Mount Adams in Skamania County. It flows in a southwesterly direction across Skamania and Clark Counties, and empties into the Columbia River just south of Woodland. It drains 731 square miles, with an average discharge of 3,479,000 acre-feet per year. Its maximum discharge was 129,000 cfs on December 22, 1933, and its minimum flow was 1 cfs and less in July 1933, due to dam construction. Flow of the River is regulated by Lake Merwin and Yale and Swift Reservoirs. These reservoirs are used by Pacific Power and Light Company for power production.

6/ Discussion in this section is limited to those water resources occurring entirely within Southwestern Washington, thereby excluding the Columbia River.

7/ From Flood Plain Information Chehalis River, prepared by the Corps of Engineers, U.S. Army, June 1971.

Queets River has its beginning on the south side of Mount Olympus in Olympic National Park. From there, it flows in a southwesterly direction across Jefferson County, to discharge in the Pacific Ocean just north of the town of Queets. Queets River drains 445 square miles, with an average discharge of 2,810,000 acre-feet per year. Its maximum discharge was 130,900 cfs on January 22, 1935, and its minimum flow was 368 cfs on September 9, 1944. There are no diversions or regulations on Queets River.

Numerous other smaller streams are tributary either to the Pacific Ocean, Willapa Bay and Grays Harbor, or the Columbia River. The high-low flow ratios of these streams are similar to those of the principal rivers. They also are of great local importance, and collectively discharge tremendous quantities of high quality water.

High Flows – Many agricultural and urban developments in Southwestern Washington have been located in lowlands along flood plains that are subject to frequent and damaging flooding. Intense rainfall during winter storms of relatively long duration is the principal cause of most major floods. Snowmelt may contribute substantial volumes of runoff to streams during some winter floods. However, floods in the spring and summer, which may be caused by various combinations of snowmelt and precipitation, usually are not severe and do little damage. Duration of floodflows usually ranges from a few hours on small streams to a few days on larger streams. The highest known floods on some major streams have lasted for several days.

Low Flows – The occurrence of low flows may be the most critical factor in the use of water resources in the Basin. Momentary minimum flows of most streams have occurred on various dates between August and January. Magnitude, frequency, and duration of low flows are influenced considerably by natural storage. Runoff from melting glaciers and perennial snowfields at high altitudes sustains summer flows in many mountain streams. Minimum flows may occur in these streams during fall and winter when melting ceases, and precipitation, occurring mostly as snow, accumulates at high altitudes.

Very good to excellent yields are obtained from mountain basins where some precipitation is stored in permeable and porous ground-water reservoirs or glaciers and perennial snowfields, or both. Yields classed as poor to fair are characteristic of low-altitude basins where streams receive only small quantities of ground-water inflow, and these basins may be nearly depleted during the dry and warm summers. Streamflows, then, are low at a time when water generally is most needed for many uses.

Lakes and Reservoirs – Variations in streamflow are influenced considerably by storage and regulation which are provided by reservoirs and natural lakes, bank storage, ground-water reservoirs, glaciers, and annual and perennial snowfields. Water storage tends to maintain more uniform flow, reduce flood peaks, and shorten periods of low flow. The effect of reservoir storage on streamflow is dependent upon the purpose and operation of the reservoir.

Large surface-water reservoirs have been constructed in Southwestern Washington on the Lewis, Cowlitz, Skookumchuck, and Wynoochee Rivers. Large reservoirs are defined as those having more than 5,000 acre-feet of storage. In addition, numerous small lakes, ponds, and reservoirs in Southwestern Washington have a total surface area of about 34,350 acres. The large natural lakes are Vancouver Lake, Quinault Lake, Lake Crescent, Silver Lake, and Ozette Lake.

Snow and Glaciers – Glaciers and perennial snowfields are highly important to the water resources of Southwestern Washington because of their short- and long-term regulations of streamflow. Glacial storage of precipitation generally occurs in winter, the greatest releases from storage being in late summer and early fall. Evaporation losses are essentially balanced by gains from condensation; thus, over long periods, runoff from glaciers is approximately equal to the precipitation received. Runoff from glacier melt may exceed annual precipitation in hot, dry years, whereas an appreciable amount of annual precipitation may go into long-term storage as ice during cool, wet years. Glaciers and perennial snowfields are located in the headwater areas of the Lewis and Cowlitz River subbasins and in the watersheds of the major streams which drain the higher parts of the Olympic Peninsula.

Water Quality – The sanitary quality of water in streams is indicated by the most probable number (MPN) of coliform bacteria in a 100 milliliter (ml) sample. MPN values are generally low at most stream stations; however, coliform-bacteria counts are frequently greater than 999 MPN per 100 ml at some stations, especially those downstream from population centers. Duration of high MPN values is not reliably determined from analysis of observed data, and the sanitary quality of many surface waters in possibly critical locations is unknown. Surface waters for which sanitary-quality data are notably deficient include tidal waters, lakes in and near inhabited localities, and reaches of streams below inhabited and developed areas.

Mean annual temperatures of the streams in Southwestern Washington average about 50 F. Temperatures of most streams seldom exceed 70° F. in summer or go below 32° F. in winter.

Stream water of Southwestern Washington is mostly a calcium bicarbonate type. It is so low in dissolved-solids and hardness that little treatment is necessary to make it suitable for most uses. Concentrations of dissolved solids observed at stream stations ranged from about 20-80 milligrams per liter (mg/l). Hardness (as $CaCO_3$) of the water never exceeded 43 mg/l.

Ground Water

The most important sources of ground water within the Basin are from alluvial, glacial, and eolian deposits (see Figure 2). Moderate to large yields of water are obtained from these deposits at many locations where adequate thicknesses of saturated sands and gravels have been penetrated. Ground water from these aquifers is generally of suitable quality for most uses.

Alluvial deposits include both terrace and flood plain deposits. Alluvial terrace deposits (QTt) occur as broad, low benches along the west and south flanks of the Olympic Mountains, and west side of the Coastal Range. Extensive terrace deposits also occur in western Clark and west central Lewis Counties. Alluvial flood plain deposits (Qal) occur mainly along the Columbia, Cowlitz, and Lewis Rivers. Alluvial deposits range in age from late Tertiary to Quaternary. They consist mainly of sands and gravels, where, with sufficient saturated thicknesses, they produce large quantities of water.

Glacial deposits (Qg) include both glacial outwash and glacial till deposits. Large glacial outwash deposits are found in western Clark County, and in Lewis County. Alpine glacial till is found in the valley on the west slopes of the Cascade and Olympic Mountains.

The till is generally impermeable and usually yields little water, whereas the glacial outwash deposits consist of permeable sands and gravels and usually yield large quantities of water. The city well of Centralia, drilled entirely in these deposits, has a reported yield of 880 gallons per minute with a drawdown of 18 feet.

Eolian deposits (Qe) consist of beach and dune deposits, and are located along several narrow coastal plains. They consist of fine to medium-grained well-sorted sand. Their thickness ranges from about 50-200 feet. They are moderately permeable, and yield moderate to large supplies of water from properly constructed and developed wells.

Volcanic rocks of Quaternary and late Tertiary Age (QTv) are permeable but are generally found only in uninhabited areas of the Cascade Mountains. A few domestic wells yield moderate supplies of water with small drawdowns. These materials are capable of yielding large quantities of good-quality water.

Late Tertiary Age sedimentary rocks (Ts) consist of clay, claystone, silt, siltstone, and very fine cemented sand. Because these materials are chiefly fine-grained, they generally yield only small quantities of water.

Volcanic flows and interbeds of Tertiary Age (Tv) include both older Tertiary rock and younger Columbia River basalt. Older volcanic rocks are low in permeability, and wells yield only small quantities of water. These rocks are mainly andesitic flows that have been greatly altered, and the fractures and joints have been filled with secondary minerals. These older volcanic rocks are located chiefly in the foothills and mountains. The younger age Columbia River basalt flows have moderate to large flows where wells have penetrated several of the permeable interflow zones. These flows outcrop in northwestern Cowlitz County and southeastern Wahkiakum County.

The consolidated sedimentary and volcanic rocks of Mezazoic and early Tertiary Age (TMz) include the central Olympic Mountain complex. These rocks are mostly massive marine sedimentary rock that include graywacke, shale, argillite, sandstone, and siltstone. Some strata contain altered volcanic rocks. Usually these rocks have low porosity and permeability, and yield only small quantities of water to wells.

Water Quality – The chemical quality of the ground water rates generally good to excellent for most uses. Water from the alluvial deposits usually has a dissolved-solid concentration of less than 250 mg/1. Most water from the marine sedimentary rocks generally has a dissolved solid concentration of less than 500 mg/1, although more highly saline water has been found in a few wells.

Ground water is mainly the calcium-magnesium bicarbonite type and is soft to moderately hard. Hardness concentration as $CaCO_3$ usually is less than 150 mg/1. The only common water-quality problem is an excess of iron in many places and, locally, some shallow wells yield brown and discolored water.

Salt water intrusion is a problem in the wells along the seacoast. Water yield in these wells is usually low, due to the fine grained sands which predominate. If the wells are pumped too hard, brackish or salt water intrudes.

Salt Water Estuaries

Grays Harbor is located in western Grays Harbor County. It is shaped like a triangle, with the cities of Hoquiam, Aberdeen, and Cosmopolis near its eastern point, Westport at its southwestern point, and Ocean Shores near its northern point. Grays Harbor is approximately 15 miles long and 6 miles wide. It provides ocean-going vessels with access to the Hoquiam-Aberdeen area, and headquarters numerous fishing fleets.

Willapa Bay is located approximately 15 miles south of Grays Harbor in western Pacific County. It is bounded on the west by Long Beach, on the north by the Shoalwater Indian Reservation, and on the east and south by U.S. Highway 101. Willapa Bay has two arms--one extends east-west for approximatley 20 miles, and the other extends north-south about 19 miles.. [8/] The bay is perhaps best known for its shellfish production, but it also provides ocean-going vessels with limited access to the Raymond-South Bend area.

Table 9 shows the area of land and water for each subbasin and for the entire Basin.

8/ Taken from Fish and Wildlife of Willapa Bay, Washington U.S. Fish and Wildlife Service, page 4.

Table 9. Summary of Land and Water Areas by Subbasins, Southwestern Washington.

Basin	Lakes Under 40 Acres	Lakes Over 40 Acres	Salt, Tidal, or Stream Over 1/8 Mile Wide	Streams Under 1/8 Mile Wide	Water Totals	Land Totals	Land Water Totals
	Acres						
Olympic	70	17,828	246,208	4,560	268,666	1,741,634	2,010,300
Chehalis	498	1,714	26,603	4,934	33,749	1,694,951	1,728,700
South Coastal	440	823	110,200	3,609	115,072	891,228	1,006,300
Cowlitz	747	18,206	1,922	3,058	23,933	1,573,867	1,597,800
Lewis	130	17,886	15,054	2,440	35,510	1,118,490	1,154,000
TOTAL	1,885	56,457	399,987	18,601	476,930	7,020,170	7,497,100

King Salmon - a fisherman's delight. These giant King Salmon can be caught in many salt water areas bordering Southwestern Washington. These fish weigh 50, 40 and 30 pounds from left to right. (Washington State Department of Commerce and Economic Development photo)

FISH AND WILDLIFE RESOURCES

Fish

Thousands of miles of streams, many lakes, and extensive estuaries in the Southwestern Washington Area contain a great variety of fish species which support diversified and intensive commercial and sport fishing activities.

Major salmon species include chinook, coho, and chum, with a few pinks in the northern watersheds and significant sockeye runs in the Quinault and Columbia Rivers. Catches of chinook and coho in 1970 by the Washington ocean and coastal river sport fisheries from Ilwaco to the East Juan de Fuca Straits at Port Angeles accounted for 710,641 salmon from 690,463 angler trips. In addition, the Washington commercial troll, net, and Indian fisheries in this area harvested over 1,361,000 salmon. Salmon stocks originating from these coastal rivers contribute heavily to commercial and sport fisheries throughout much of the length of the Pacific Coast.

Game fish frequent all suitable fresh water lakes, rivers, and streams. These include steelhead, sea-run and native cutthroat, rainbow, and eastern brook trout. Others species of lesser importance include whitefish, various bass species, perch and crappie. A large variety of less desirable species, including the sculpins, sucker, shiner, carp, squawfish, stickleback, dace and chub, inhabit most basin waters. The Olympic mudminnow, a threatened species, and the sandroller and leopard dace (status unknown) inhabit some basin streams. The steelhead and resident fish harvest exceeds 2 million fish annually, providing about a million fishman days of recreation.

Good aquatic habitat is generally present for both anadromous and resident fish in the coastal rivers. Over 4,000 miles of streams are utilized by anadromous fish, and one or more species migrate up these streams every month of the year. Lower reaches serve as transportation and rearing areas, while middle and upper reaches and tributaries serve as transportation, spawning, and rearing areas.

Quality and abundance of fish habitat are directly influenced by both natural and man-caused conditions. Although current levels of fish production from coastal watersheds satisfy present demands, it is the opinion of fisheries management agencies that natural production can be significantly increased through expanded stream habitat protection and improvement programs and stream flow augmentation.

The bays, lower rivers, and Pacific Coastline also provide habitat for large populations of marine species such as cod, flounder, ocean perch, ling cod, herring, hake, rockfish, and other bottom fish. These species support a major trawl fishery by commercial vessels based out of the Puget Sound region. Sturgeon, smelt, and shad are found within Grays Harbor and the lower Chehalis River, as well as the lower portion of the Columbia River, where they support minor commercial fisheries. Surf and jetty fishing are popular family recreation activities for many of these marine species. The production of shellfish is exceptionally good along the Washington coast. Some shellfish species which inhabit ocean beaches, estuaries, and bays include razor, horse, little neck, cockle, soft-shell and butter clams, as well as several species of lesser importance such as piddock, jackknife, and mussels. Extensive razor clam populations provide an annual recreational sport harvest of 10 million clams from 650,000 digger trips along 60 miles of open ocean beaches. Commercial harvest has declined in recent years, due to past exploitation of commercial digging areas. Many concentrations of hardshell clams are located within private oyster grounds in Grays and Willapa Harbors, and receive little sport harvest.

The Pacific oyster industry is very important in Willapa Bay. Over 3.5 million pounds are harvested annually. The greatest commercial harvest of Dungeness crab in the Pacific Northwest is located along the Washington coast. Some 13.5 million pounds of Dungeness crabs were landed in 1970, mainly from shallow offshore waters and coast-line bays. Crabbing is a popular sport along jetties and in estu-aries, particularly in Grays Harbor and Willapa Bay.

Wildlife

The Southwestern Washington Basin supports a wide variety of wildlife. Big game species include black-tailed deer, Roosevelt elk, black bear, cougar, a few mountain goat and Columbian white-tailed deer (a threatened subspecies of white-tailed deer). Upland game include grouse, pheasant, quail, band tailed pigeon, dove, and rabbits.

Fur animals are distributed throughout the basin. Those which require licenses to trap include beaver, muskrat, mink, river otter, martin, weasel, raccoon, gray fox, lynx and bobcat. Coyote, skunk, red fox, and opossum head the list of nonprotected fur animals harvested commercially. Sea otter obtained from Alaska have been released along the Olympic Coast with the hope that these rare animals will become re-established.

Sheltered bays, estuaries and fresh water lakes and ponds provide both resting and nesting areas for migratory waterfowl. Principal wintering species include mallard, pintail, widgeon, teal, wood duck, coot, snipe, scaup, canvasback, goldeneye, shoveler, ruddy duck, merganser, scoter, cormorant, white-fronted goose, black brant, Canada goose, and snow goose. Southerly fall migration into Southwestern Washington begins in August, peaks in October or November, and trails off in January.

Numerous other species of wildlife inhabit the basin. Included are marine mammals, song birds, birds of prey, pelagic birds, shore birds, forest rodents, amphibians and reptiles.

A large sport hunting industry and a smaller commercial industry are based on this wildlife resource. An estimated 1,000,000 hunter-days are spent annually in the basin. Commercial harvest of fur-bearers amounts to slightly less than $200,000 annually.

Wildlife Habitat – Southwestern Washington is rural in character. About 88 percent is forested and 6 percent is agricultural. Timber harvesting and agricultural operations have opened the forest canopy and actually improved wildlife habitat, in most cases. Much of the Basin lies below 2,000 feet in elevation, making suitable winter range available for big game. In general, land use activities such as logging and farming have been beneficial to wildlife by creating "new" habitat in virgin timber stands. In specific instances, however, such uses have been detrimental. Only by planned land use and habitat enhancement programs can present levels of wildlife be maintained or increased.

Mt. Adams - the southeastern boundary of Southwestern Washington Study Area. (Photo - Washington State Department of Commerce and Economic Development)

NATURAL ENVIRONMENT

From its mountain crests to its sparkling coastline, Southwestern Washington has a variety of natural environmental resources. These take various forms: open space, scenery, varieties of tree and plant cover, rivers, lakes, estuaries, geologic formations, numerous kinds of wildlife, and hosts of other natural attributes. The basin, with the exception of a few urban areas, is rural in nature. Figure 7 provides location information on prominent resources having esthetic or historical significance.

Scenic Beauty

Snow-capped mountains, rolling forested foothills, and miles of ocean beach dominate the landscape. Small farms, rural communities, and broad river bottoms break up this major expanse of topography.

Some of the principal scenic areas are located in national parks, national forests and state park areas. These include a portion of Mount Rainier National Park, the highest point in the state; Olympic National Park with its glaciers; rain forests and ocean beaches; and the Wilderness and Scenic Areas in the Gifford Pinchot and Olympic National Forests. In addition, there are many spectacular scenic areas located in state parks, some along the coast, and others adjoining the many rivers that drain the Basin. (See Figures 7 and 8.)

Complementing the public recreation system are many small private recreational areas, developed mostly by power companies and the forest industry on their industrial holdings. These enhance the many miles of valley bottom, with its deep forest and open gravel bars. These private lands, along with farming areas, offer the recreationist vast opportunities for hunting, fishing, and other activities.

Highly scenic natural lakes include Crescent, Ozette and Quinault on the Olympic Peninsula, and Silver and Spirit Lakes in the Toutle River drainage. Three large reservoirs on Lewis River and two on the Cowlitz, developed for power production, add to the Southwestern Washington water surface area. A flood control and water supply reservoir on Wynoochee River adds surface water to scenic Wynoochee Valley. Public and private developments on these water bodies afford both local and transient population an opportunity to enjoy the area.

The Basin has many hundred miles of free-flowing rivers, 641 miles of which have been identified as having significant scenic or recreational potential. Major rivers include the Hoh, Queets, Quinault, Humptulips, Upper Cowlitz, North Fork Toutle, Kalama and Upper Lewis Rivers.

U. S. DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE

ENVIRONMENTAL RESOURCES
SOUTHWEST WASHINGTON STUDY AREA

1974

FIGURE 7

Major drainage basins form large estuaries where they enter the Pacific Ocean. These include the estuaries at the mouth of the Columbia River, Willapa Bay, and Grays Harbor. These areas are nationally famous for their natural scenic qualities. They offer opportunities for fishing, harvesting shellfish and many other shoreline recreational opportunities.

Connecting the estuaries and running northward to the northwest tip of the Olympic Peninsula are miles of sandy beach, rugged rock headlands, pounding surf, natural sea caves, coves, inlets, reefs and sand dunes. These areas offer the recreationist outstanding scenery and the opportunity to enjoy clamming, beachcombing, hiking, and general relaxation.

Influencing Factors

The 427,000 people living in the 7-million-acre basin have altered the landscape to achieve the life style that presently exists. Early settlers utilized open prairie-like areas for the initial development of agriculture, and then cleared timber to enlarge production. Eventually, most of the fertile soil areas in the stream valleys were cleared for agricultural use. Some of this land was ultimately developed for urban use and is so used today.

Urban sprawl is characteristic of the periphery of urban centers. This is especially noticeable in Clark County around Vancouver, and in Grays Harbor County near Aberdeen. Rural nonfarm residences beyond the urban centers are also prevalent. These types of development have resulted in removal of some of the most productive cropland from agricultural uses. Urban centers have been located mostly on rivers of some magnitude, with resultant flood damage during periods of peak flow. Urban use of the flood plain has reduced opportunities for agriculture, river greenways, parks, trails or fisherman access--all of which are more appropriate for floodway areas than is urbanization.

A review of the early fire history of the Basin reveals many periods with catastrophic forest fires. Indians burned over much of the landscape to promote forage growth and continued production in their huckleberry fields. Some existing Douglas-fir stands resulted from early lightning and man-caused fires. Explorers recorded vast burned-over areas in the late 1850's. The Yacolt burn of 1902 destroyed 238,000 acres of timber. Serious fires occurred in the 1914-18 period, again in the late 1920's and through the 1930's. The last serious fire period was 1951-2. Although some present old-growth timber stands are the result of earlier fires, the burns had serious impact on the environment.

Undoubtedly serious erosion followed some of the more extensive burns. Had these burns occurred during current times, with much more dependence on these natural resources, the socio-economic impact would have been more serious.

Other natural disasters have affected the environment. Periodic windstorms raise havoc in forest areas. The Olympic Blowdown of 1921 felled extensive timber areas on the Olympic Peninsula. The Columbus Day storm of 1962 caused similar damage.

Today, man's hand is exerting a heavier role in changing the landscape. This has come about mainly from utilization of natural resources. Harvesting timber, building roads, industrial development in estuaries, urbanization, heavy construction, and land clearing have all been responsible. Depending on one's point of view, this has not been all bad. Uncontrolled, this utilization can be a destructive agent. But, properly controlled or utilized, these factors can enhance the quality of the Basin's natural environment.

ECONOMIC DEVELOPMENT

ECONOMIC DEVELOPMENT

POPULATION

The Southwestern Washington Economic Study Area had a population slightly over 327,000 in 1970 (Table 10). This represented an increase of 56 percent over the 1940 population. The population of Washington grew 96 percent during the same 30-year period. Clark County accounted for 24 percent of the study area's population in 1940, and for 39 percent in 1970.

Table 10. Population by County for Selected Years, Southwestern Washington, Economic Study Area, 1940-1970.

County	1940	1950	1960	1970
	Number			
Clark	49,852	85,307	93,809	128,454
Cowlitz	40,155	53,369	57,801	68,616
Grays Harbor	53,166	53,644	54,465	59,553
Lewis	41,393	43,755	41,858	45,467
Pacific	15,928	16,558	14,674	15,796
Skamania	4,633	4,788	5,207	5,845
Wahkiakum	4,286	3,835	3,426	3,592
Total	209,413	261,256	271,240	327,323

Source: Bureau of Census, U.S. Department of Commerce.

The Economic Study Area includes all of Clark, Cowlitz, Grays Harbor, Lewis, Pacific, Skamania and Wahkiakum Counties. The area differs from the hydrologic area or basin in that it excludes those portions of Clallam and Jefferson Counties which lie west of the Coast Range and includes all of Skamania County. (See map p. 48) This distinction was necessary since economic data have historically been collected on a county basis.


C A N A D A
I D A H O
O R E G O N
WASHINGTON
Southwestern River Basin
LOCATION MAP
VANCOUVER ISLAND
STRAIT OF JUAN DE FUCA
Victoria
CLALLAM
JEFFERSON
Mt. Olympus
Hood Canal
LEGEND
ECONOMIC STUDY AREA BOUNDRY
BASIN BOUNDRY
COUNTY LINE
N
PACIFIC OCEAN
MASON
THURSTON
HOQUIAM
ABERDEEN
Grays Harbor
GRAYS HARBOR
Willapa Bay
Mt. Rainier
CENTRALIA
CHEHALIS
PACIFIC
WAHKIAKUM
LEWIS
COWLITZ
SKAMANIA
Columbia River
Astoria
OREGON
LONGVIEW
KELSO
Mt. St. Helens
Mt. Adams
CLARK
VANCOUVER
WASHINGTON
ECONOMIC STUDY AREA MAP
SOUTHWESTERN WASHINGTON
10 0 10 20 30
Scale in Miles

The change in population distribution within the area by urban and rural classifications has followed the state trend, but at a much slower rate. During 1970, 73 percent of the state's population was classified as urban, whereas the study area was only 53 percent urban (Table 11). Rural population of the area was 87 percent rural-nonfarm.

Table 11. Washington State and Southwestern Washington Population Distribution at Selected Years.

Year	Washington State		Southwestern Washington	
	Urban	Rural	Urban	Rural
	Percent		Percent	
1950	63	37	47	53
1960	68	32	49	51
1970	73	27	53	47

Source: Bureau of the Census, U.S. Department of Commerce.

Net migration by age and sex per persons living in the Economic Study Area are shown in Table 12. Outmigration was the trend for both males and females during the period 1950-1960. Of the 12,848 males that composed the net loss due to civilian migration, 45 percent came from the 15-24 age group and 16 percent from the 25-34 age group. The 12,560 females had a similar outmigration pattern: 41 percent from the 15-24 age group, and 17 percent from the 25-34 age group. Net migration from 1960-1970 reversed the 1950-1960 trend with an increase of over 25,000 males and 30,000 females within the Economic Study Area. Approximately 36 percent of these males were in the 15-24 age group.

Minority races in 1970 totaled 5,014 persons (Table 13). Of this total, 55 percent were Indian, 16 percent were Negro, and 29 percent were classified as all other races. Grays Harbor County recorded 38 percent of the total.

Table 12. Net Migration, by Sex, Southwestern Washington Economic Study Area, 1950-1960 and 1960-1970

Age Group	1950-1960		1960-1970	
	Male	Female	Male	Female
	----------Number----------			
Under 5.....	61	-373	-3	344
5-14.....	-1,960	-1,947	5,479	4,373
15-24.....	-5,735	-5,117	9,244	10,657
25-34.....	-2,019	-2,117	5,451	4,698
35-44.....	-1,598	-1,606	-317	-599
45-54.....	-1,280	-939	1,672	3,093
55-64.....	-459	-377	3,596	4,254
65-74.....	-66	-191	-54	1,173
74 & over.....	208	107	444	2,573
All Ages.....	-12,848	-12,560	25,512	30,566

SOURCE: U. S. Census of Population.

Table 13. Race, by Sex, for Counties, Southwestern Washington Economic Study Area, 1970

County	Total	White	Negro and other races			
			Total	Negro	Indian	All Other
Clark:						
Male	62,968	62,210	758	309	220	229
Female	65,486	64,755	731	260	178	293
Cowlitz:						
Male	34,136	33,754	382	56	183	123
Female	34,480	34,065	415	53	174	188
Grays Harbor:						
Male	29,741	28,782	959	19	736	204
Female	29,812	28,876	936	17	729	190
Lewis:						
Male	22,500	22,290	210	30	130	50
Female	22,967	22,786	181	9	112	284
Pacific:						
Male	7,902	7,765	137	13	85	39
Female	7,894	7,765	129	7	78	44
Skamania:						
Male	2,979	2,910	69	11	52	6
Female	2,866	2,816	50	1	41	8
Wahkiakum:						
Male	1,868	1,834	34	--	33	1
Female	1,724	1,701	23	--	16	7

SOURCE: Bureau of Census, U. S. Department of Commerce.

Population of incorporated cities and towns fluctuated greatly during the period 1930-1970 (Table 14). Twenty-four percent of the 34 incorporated cities and towns decreased in population between 1960 and 1970. Variations in city growth are related to changing conditions in the forest industry, tourist trade, and commercial activities. The western portion of Lewis County shows the effects of a shifting forest industry. As the Willapa Hills were logged, towns such as Pe Ell and Vader grew and then declined in population. The town of Raymond had a peak population of 4,260 in 1920 which declined to 3,126 by 1970. Aberdeen and Hoquiam developed into Grays Harbor's commercial headquarters until 1930, and then decreased in population. There were only 11 cities in the area during 1970 which had populations of more than 2,500 persons and, therefore met the census criterion of urban population.

SOCIAL STRUCTURE

The median number of school years completed in the Economic Study Area in 1960 was 10.9 years. This was lower than the median of 12.1 years for Washington State. About 56 percent of the area residents over 25 years of age in 1970 had completed high school, as compared with 63 percent for Washington State. (Table 15).

Immigrant groups vary considerably in the area. During 1970, only 2 percent of the Lewis County population was foreign-born, as compared to 5 percent for Wahkiakum County. Homesteading and opportunities in fishing and forestry during the latter part of the 19th century brought many persons from Europe, Canada, and Asia to the Southwestern Washington Basin. In 1890, nearly one-third of the Pacific County population was foreign-born.

Table 14. Population of Incorporated Cities and Towns, Southwestern Washington Economic Study Area, 1930-1970

City or town and county	Year and number of persons				
	1930	1940	1950	1960	1970
Aberdeen, Grays Harbor	21,723	18,846	19,653	18,741	18,489
Battleground, Clark	------	------	------	888	1,438
Camas, Clark	4,239	4,433	4,725	5,666	5,790
Castle Rock, Cowlitz	1,239	1,183	1,255	1,424	1,647
Centralia, Lewis	8,058	7,414	8,657	8,586	10,054
Chehalis, Lewis	4,907	4,857	5,639	5,199	5,727
Cosmopolis, Grays Harbor	1,493	1,207	1,164	1,312	1,599
Elma, Grays Harbor	1,545	1,370	1,543	1,811	2,227
Hoquiam, Grays Harbor	12,766	10,835	11,123	10,762	10,466
Ilwaco, Pacific	750	656	628	518	506
Kalama, Cowlitz	940	1,028	1,121	1,088	1,106
Kelso, Cowlitz	6,260	6,749	7,345	8,379	10,296
LaCenter, Clark	219	193	204	244	300
Long Beach, Pacific	396	620	783	665	968
Longview, Cowlitz	10,652	12,385	20,339	23,349	28,373
McCleary, Grays Harbor	------	------	1,175	1,115	1,265
Montesano, Grays Harbor	2,460	2,242	2,328	2,486	2,647
Morton, Lewis	461	778	1,140	1,183	1,134
Mossyrock, Lewis	------	------	356	344	409
Napavine, Lewis	181	220	242	314	377
North Bonneville, Skamania	------	643	564	494	459
Oakville, Grays Harbor	469	418	372	377	460
PeEll, Lewis	891	825	787	593	582
Raymond, Pacific	3,828	4,045	4,110	3,301	3,126
Ridgefield, Clark	607	643	762	823	1,004
South Bend, Pacific	1,798	1,771	1,857	1,671	1,795
Stevenson, Skamania	400	563	584	927	916
Toledo, Lewis	530	523	602	499	654
Vader, Lewis	465	479	426	380	387
Vancouver, Clark	15,766	18,788	41,664	32,464	42,493
Washougal, Clark	1,206	1,267	1,577	2,672	3,388
Winlock, Lewis	864	861	878	808	890
Woodland, Cowlitz	1,094	980	1,292	1,336	1,499
Yacolt, Clark	295	297	411	375	488

Bureau of the Census, U.S. Department of Commerce.

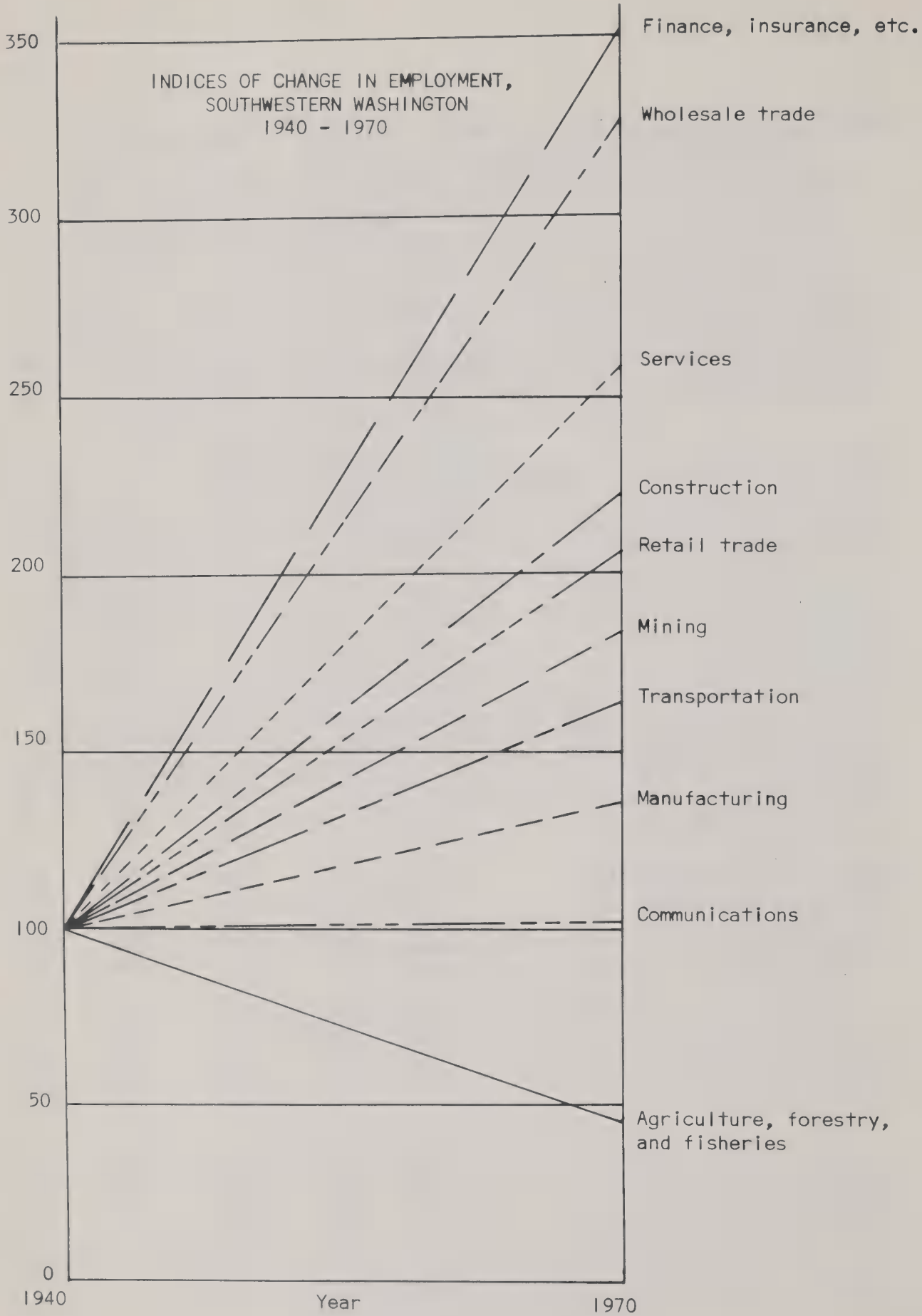

INDICES OF CHANGE IN EMPLOYMENT,
SOUTHWESTERN WASHINGTON
1940 - 1970
350
300
250
200
150
100
50
0
1940
Year
1970
Finance, insurance, etc.
Wholesale trade
Services
Construction
Retail trade
Mining
Transportation
Manufacturing
Communications
Agriculture, forestry,
and fisheries

Table 15. Years of School Completed for Residents 25 years Old and Older, Southwestern Washington Economic Study Area and State of Washington, 1970.

School years completed		Southwestern Washington Number	Southwestern Washington Percent	State Percent
No school years completed		903	0.5	0.7
Elementary:	1 to 4 years	2,941	1.6	1.5
	5 to 7 years	12,336	6.9	5.4
	8 years	25,984	14.5	11.4
High School:	1 to 3 years	35,537	19.9	17.6
	4 years	65,198	36.4	36.2
College :	1 to 3 years	21,853	12.2	14.5
	4 years	14,195	7.9	12.7

Source: U.S. Department of Commerce, U.S. Census of Population, 1970, "General Social and Economic Characteristics," PC(1), 49C, Washington.

MAJOR TYPES OF ECONOMIC ACTIVITY

Employment

Over 115,000 persons were employed in the Southwestern Washington Economic Study Area in 1970 (Table 16). This number compares with approximately 94,000 in 1960 and 71,000 in 1940.

Employment in manufacturing within the area showed a large increase from approximately 27,770 in 1940, to 37,700 in 1970. Wholesale trade and finance, insurance and real estate employment more than tripled during this same 20-year period (see graph P. 54). Agriculture, forestry, and fisheries, however, decreased from 10,300 in 1940 to approximately 4,700 in 1970, with the bulk of the decrease taking place between 1950 and 1960. This decrease in agricultural employment has been caused, in part, by increased mechanization and improved farming methods resulting in less demand for farm labor. Furthermore, during the period 1949-1964, there was a decrease in acreage of total cropland and total pasture.

Timber Industry
Southwestern Washington

Table 16. Employment in Various Economic Sectors, Southwestern Washington Economic Study Area, 1940, 1950, 1960, and 1970

Employment Sector	1940	1950	1960	1970
	Number of Employees			
Agriculture, forestry, and fisheries	10,300	9,845	6,248	4,717
Mining	168	205	81	310
Contract construction	3,489	5,918	5,755	7,700
Manufacturing	27,658	34,248	35,033	37,709
Transportation	3,313	4,281	4,542	5,508
Communication	1,185	2,696	2,201	1,197
Utilities & sanitary services	------	------	1,277	2,263
Wholesale trade	1,006	1,871	1,955	3,292
Retail trade	8,803	13,593	13,423	18,072
Finance, insurance, & real estate	1,190	1,897	2,303	4,192
Services	10,024	14,558	18,906	25,931
Public administration & armed forces	3,463	3,611	4,041	4,638
TOTAL	70,599	92,723	94,488	115,529

Census of Population, U.S. Department of Commerce and Office of Business Economics.

Approximately 31 percent of services employment during 1970 was concerned with private and government elementary and secondary schools and colleges. Other personal services provided an additional 12 percent of employment in this category. Entertainment and recreation accounted for some 3 percent of total services employment.

The number of persons employed in the Economic Study Area increased from 7,099 during 1960 to 8,682 in 1970. Grays Harbor County had the highest percentage of unemployment during this period, with 8.1 percent

Fishing boats at Westport.

Salmon canning

The fishing fleet is in.

and 9.7 percent, respectively. Unemployment, by county, for the two time periods was as follows:

County	1960	1970
	-----Percent------	
Clark	6.7	6.4
Cowlitz	6.8	7.2
Grays Harbor	8.1	9.7
Lewis	6.9	6.9
Pacific	6.6	6.9
Skamania	7.2	8.6
Wahkiakum	3.7	5.4

Income and Earnings

Median per capita income in 1969 ranged from $3,218 for residents of Clark County to $2,508 for persons living in Skamania County.

Average annual wages per person in covered employment increased approximately 75 percent between 1950 and 1965 (Table 17). The county with the largest relative change in average wages during this 15-year period was Skamania County, which more than doubled its average wages per person and experienced a rate of change almost 20 percent age points greater than the state as a whole.

Table 17. Average Annual Wages Per Person in Covered Employment, Southwestern Washington Economic Study Area, 1950-1965.

County	Average Wage				Percent Change
	1950	1955	1960	1965	1950-1965
	----------dollars----------				
Clark	3,357	4,183	4,990	5,860	74.6
Cowlitz	3,365	4,233	5,115	6,256	85.9
Grays Harbor	3,366	4,138	4,573	5,520	64.0
Lewis	3,077	3,699	4,281	5,357	74.1
Pacific	3,058	3,544	4,110	5,065	65.6
Skamania	3,155	4,347	4,733	6,362	101.6
Wahkiakum	3,018	3,947	3,899	5,398	78.9
Area average	3,286	4,066	4,757	5,770	82.3
State average	3,286	4,187	5,089	6,069	84.7

Source: Washington State Department of Employment Security, 9-12-66.

TRANSPORTATION

Most urban and farm areas are well served by transportation facilities for marketing manufactured goods, crops, livestock, and livestock products within and outside of the area. Interstate Highway 5, a multilane highway, passes through the main population centers in Clark, Cowlitz and Lewis Counties. Both Seattle, Washington, and Portland, Oregon, are less than two hours away from Chehalis by truck, which is the main carrier of agricultural commodities. Pacific and Grays Harbor Counties are well serviced by U.S. Highway 101, which leads northward to Aberdeen and Hoquiam and connects with highways leading eastward to Puget Sound markets. Highways connect the Economic Study Area with the eastern portion of the state via crossings through the Cascades to Yakima.

Railroads assist in the movement of farm crops to major marketing centers, as well as in the transportation of lumber and logs for both domestic use and export.

AGRICULTURE

In 1969, the average market value of all agricultural products sold, per farm, in the Economic Study Area ranged from $8,783 in Skamania County to $12,972 in Grays Harbor County, according to the Census of Agriculture. For the state, the comparable figure was $22,661 per farm.

Average farm size in 1969 for the study area was slightly over 113 acres; the state's average was approximately 516 acres. This difference in average farm size can be further identified by investigating the intensity of farm operations. In 1969, census data estimated the value of land and buildings per farm at $63,145; the corresponding value for all farms in the state was $115,487. Table 18 shows per-acre value of land and buildings. In 1969, per-acre value in Clark County was more than three times that of the state average. In fact, all counties within the area had an average per-acre value greater than the state average during 1969.

Table 18. Value of Land and Buildings Per Acre, Southwestern Washington Economic Study Area, 1949-1969.

County	1949	1954	1959	1964	1969
			Dollars		
Clark	211	279	312	483	750
Cowlitz	156	213	267	275	554
Grays Harbor	140	176	201	287	491
Lewis	115	163	169	243	474
Pacific	218	245	250	281	476
Skamania	59	121	187	249	477
Wahkiakum	161	256	267	274	465
STATE OF WASHINGTON	87	122	149	154	224

Source: Census of Agriculture, U.S. Department of Commerce.

A cranberry bog
near Grayland.

Blueberries in Chehalis
Valley

Blueberries ready
for picking.

Land in farms within the Economic Study Area decreased from 882,000 acres in 1949 to 462,800 acres in 1969. This 48 percent decrease of land in farms was due to decreases, not only in harvested cropland, but also in woodland pasture (Table 19). During this same period, the number of farms decreased from 11,799 to 4,090. This 65 percent decrease in 20 years was 2½ times greater than the change in total number of farms in the state.

Table 19. Cropland and Pasture Acreage, Southwestern Washington Economic Study Area, 1949-1969.

Land Use	1949	1954	1959	1964	1969
	Acres				
Total cropland	316,048	305,425	280,939	289,890	233,505
Cropland harvested	169,145	167,207	157,609	142,655	109,590
Cropland pastured	109,964	109,283	99,679	126,392	113,379
Cropland not harvested	36,939	28,935	23,651	20,843	10,536
Cropland irrigated	3,372	8,032	10,548	8,172	11,433
Total pasture	430,042	444,731	334,689	350,692	156,207 a/

Source: Census of Agriculture, U.S. Department of Commerce.
a/ Farms with sales of $2,500 and over.

There were 7,261 farms in the area in 1964. By 1969, this number had decreased to 4,090 (Table 20). During 1964, approximately 74 percent of the farms had sales below $2,500; in 1969, this percentage had decreased to 58, with a corresponding decrease of 3,052 farms with sales of under $2,500. During the same five years, larger commercial farms with sales of $30,000 and over increased 68 percent, from 241 to 406 farms.

In comparing 1964 and 1969 agricultural statistics, it should be noted that census procedures used in 1969 differed from those employed in 1964. Mail returns were used in 1969 with field followup limited primarily to commercial farms. By new definitions, timber farms were excluded. These changes would account for some of the decrease in numbers of farms between 1964 and 1969.

Major Crops

The major crops grown in the Southwestern Washington Economic Study Area are associated with large livestock and livestock products industries. In 1966 there were 316,700 acres of cropland in the area. Of this total, 292,600 acres were nonirrigated and 91 percent of this acreage was associated with forage and grain crops (Table 21). Of the remaining 25,550 acres of nonirrigated cropland, only 11,930 acres were harvested.

Crop distribution in 1966 was similar in irrigated and nonirrigated areas. Of the 24,170 acres of irrigated cropland, 73 percent were associated with small grains for hay, rotation pasture, and corn for silage (Table 22).

The berry industry is an important segment of the Southwestern Washington economy. Grays Harbor and Pacific Counties produce virtually all of the state's cranberries. In 1966, these two counties produced 13.5 million pounds of cranberries. Other important berry crops are strawberries, raspberries, cultivated blackberries, and blueberries.

Recent crop history of the area reflects to a large degree economic changes which have occurred. These changes show the influence of new market outlets. Crops such as alfalfa, grass silage, and corn silage showed significant increases from 1949-1969 (Table 23).

Table 20. Number of farms, by Value of Agricultural Products Sold, Southwestern Washington Economic Study Area, 1964 and 1969.

Dollars of sales	Number of farms, and year 1964	1969
1 to 249	2,068	499
250 to 499	1,007	354
500 to 999	1,117	570
1,000 to 1,499	597	570
1,500 to 1,999	358	280
2,000 to 2,499	261	253
2,500 to 4,999	585	525
5,000 to 7,499	252	245
7,500 to 9,999	175	110
10,000 to 14,999	260	196
15,000 to 19,999	160	113
20,000 to 29,999	180	139
30,000 to 39,999	79	119
40,000 to 59,999	79	117
60,000 to 79,999	83	57
80,000 and over	83	113
TOTAL	7,261	4,090

Source: Census of Agriculture, U.S. Department of Commerce, 1969.

Table 21 - Nonirrigated Cropland, by County, Southwestern Washington Economic Study Area, 1966.

Crop description	County							
	Clark	Cowlitz	Lewis	Skamania	Wahkiakum	Grays Harbor	Pacific	Total
	current normal acres[a/]							
Corn for silage	2,740	300	200	0	400	500	0	4,190
Oats	2,000	1,580	3,190	0	0	530	0	7,300
Rotation hay	34,640	9,000	26,700	0	1,210	5,200	4,090	80,840
Rotation pasture	40,300	16,000	39,340	0	0	15,570	18,050	129,260
Cropland pasture	1,700	1,860	0	200	8,580	0	1,120	13,460
Small grains for hay	0	700	2,260	0	0	0	0	2,960
Alfalfa hay	0	0	1,810	850	40	220	0	2,920
Clover-Timothy	0	0	4,620	1,310	1,820	1,580	0	9,330
Wild hay	0	0	3,530	380	390	1,450	0	5,750
Other hay	0	0	1,590	740	50	260	0	2,640
Grass silage	0	0	3,450	10	1,050	3,890	0	8,400
Barley	930	30	540	0	0	140	0	1,640
Lettuce and romaine	230	0	0	0	0	0	0	230
Lima beans & other beans	620	30	0	0	0	0	0	650
Cabbage, broccoli, cauliflower	110	0	0	0	0	0	0	110
Winter wheat	300	10	740	0	0	0	0	1,050
Spring wheat	70	0	110	0	0	20	0	200
Rye	100	0	100	0	0	80	0	280
Fruits	400	20	130	410	0	90	0	1,050
Nuts	380	70	280	20	0	10	0	760
Other berries	590	140	90	110	0	140	0	1,070
Potatoes	0	80	0	0	0	160	0	240
Strawberries	0	60	120	0	0	0	0	180
Sweet corn	0	70	230	0	0	10	0	310
Sweet green peas	0	220	1,400	0	0	1,480	0	3,100
Squash and melons	0	150	0	0	0	0	0	150
Other closer grown crops	0	60	870	0	0	0	0	930
Conservation use only	0	350	60	0	0	100	0	530
Government diversion	0	0	420	0	0	0	0	420
Temporary idle	0	590	1,260	0	0	500	0	2,350
Summerfallow	0	0	0	0	0	120	70	690
Cropland not harvested	0	0	0	0	0	1,340	0	1,340
Openland not converted	1,500	1,980	3,570	640	0	0	0	7,690
Crop failure	320	200	0	80	0	0	0	600
TOTALS	86,930	33,500	96,610	4,750	13,540	33,440	23,830	292,600

Soil Conservation Service and Economic Research Service data from Washington State soil resource group study.

a/ Current normal acreage reflects the average of the acreage and production for the state, as reported by the Statistical Reporting Service for the three years 1965, 1966, and 1967. This normalization was intended to establish a set of estimates which reflect current production technology and practices.

Table 22. Irrigated Cropland, by County, Southwestern Washington Economic Study Area, 1966.

Crop Description	County						
	Clark	Cowlitz	Lewis	Wahkiakum	Grays Harbor	Pacific	Total
	current normal acres a/						
Potatoes	430	120	20	0	0	0	570
Mint crops	370	580	0	0	0	0	950
Seed crops	10	0	0	0	0	0	10
Strawberries	460	70	260	0	20	0	810
Squash and melons	130	0	20	0	0	0	150
Small grain for hay	400	0	400	0	360	0	1,160
Rotation pasture	4,310	880	4,400	550	4,980	0	15,120
Corn for silage	0	400	850	90	0	0	1,340
Sweet corn	0	250	150	0	0	0	400
Lettuce and romaine	0	10	0	0	0	0	10
Parsley, dill, etc.	0	250	0	0	0	0	250
Cabbage, broccoli, cauliflower	0	50	0	0	0	0	50
Apples	0	20	0	0	0	10	30
Pears	0	20	0	0	0	10	30
Other berries	0	160	100	0	210	2,180	2,650
Sweet green peas	0	0	0	0	330	0	330
Cropland pasture	0	0	0	0	300	0	300
Plums and prunes	0	0	0	0	0	10	10
Total Irrigated Cropland	6,110	2,810	6,200	640	6,200	2,210	24,170

Soil Conservation Service & Economic Research Service data from Washington State soil resource group study.

a/ Current normal acreage reflects the average of the acreage and production for the state, as reported by the Statistical Reporting Service, for the three years 1965, 1966, and 1967. This normalization was intended to establish a set of estimates which reflect current production technology and practices.

Table 23. Production of Major Crops, Southwestern Washington Economic Study Area, 1949-1969

Crop	Units	1949	1954	1959	1964	1969 a/
		production				
All Hay:						
Alfalfa	Ton	11,352	17,816	15,434	24,663	19,643
Clover - Timothy	Ton	62,093	100,821	117,345	131,685	76,155
Oats, wheat, barley & rye mixtures	Ton	35,109	19,123	11,797	8,322	7,252
Wild hay	Ton	18,883	12,025	11,780	14,973	11,859
Other hay	Ton	35,784	22,970	18,827	6,547	9,804
Grass silage	Ton	36,295	106,262	94,455	106,421	66,512
Corn silage	Ton	17,068	9,396	11,695	37,664	65,167
Small grains:						
Corn for grain	Bu.	7,416	1,682	652	1,035	2,795
Winter wheat	Bu.	98,498	87,166	53,470	39,596	30,613
Spring wheat	Bu.	50,571	74,095	61,574	6,029	12,975
Oats	Bu.	985,199	1,102,117	722,844	264,665	264,922
Barley	Bu.	92,393	112,204	209,303	87,763	78,447
Dry peas	Lbs.	238,213	26,000	0	3,000	0
Potatoes	Cwt.	104,071	100,009	152,364	159,100	171,950
Berries	Lbs.	5,091,448 b/	15,080,292	21,227,166	15,279,658	na

Census of Agriculture, U.S. Department of Commerce.

a/ Commercial farms only.

b/ Cranberries not included.

Small grains production (corn for grain, wheat, oats, and barley) decreased from approximately 1.2 million bushels in 1949 to 0.4 million bushels in 1969. The large production of oats in the area is related to both the cattle and poultry feed markets. Large commercial production of small grains has not developed, due to the physical drawbacks of the area to such crops. Lands from which cereal crops were formerly harvested have been put into pasture or devoted to growing hay.

According to the Census of Agriculture, harvest of vegetables for sale increased from 2,174 acres in 1949 to approximately 6,415 acres in 1969. Major vegetables grown in the area include sweet green peas, sweet corn, broccoli, snap beans, and cucumbers.

Major Livestock Enterprises

The primary farming activity of the area involves livestock and livestock products. Since the earliest farm settlements, livestock and their products have played an important part in the area's agricultural economy. Dairy, beef cattle, and poultry industries have developed to where they are the primary farming activities.

Dairy cattle comprise the greatest livestock numbers in Southwestern Washington.

Livestock numbers increased substantially during the period 1949-1969 (Table 24). The number of cattle and calves increased 11 percent; cows, including heifers, 3 percent; steers and bulls, 46 percent; and sheep and lambs, 4 percent. The only major category of livestock which experienced a decline during this 20-year period was hogs and pigs; with a 51 percent reduction over this period.

Chickens, four months old and older, experienced an increase of 124 percent during the period 1949-1969. Turkeys and turkey fryers raised for sale experienced a considerable rate of decline during this same period. Lewis County produced 60 percent of all turkeys in the Economic Study Area in 1964. According to Census of Agriculture data, the number of poultry and poultry products farms decreased from 3,696 in 1949 to 512 in 1964.

Table 24. Numbers of Livestock and Poultry, Southwestern Washington Economic Study Area, 1949-1969

Subject	1949	1954	1959	1964	1969	
	number					
Cattle and calves	113,797	135,696	132,632	155,373	126,429	
Cows, including heifers	56,664	62,578	58,569	70,710	58,659	
Steers and bulls	12,832	25,563	26,671	34,535	18,710	a/
Hogs and pigs	10,272	9,665	10,672	3,557	5,061	
Sheep and lambs	7,918	11,590	14,960	9,526	8,227	
Chickens 4 mos. and over	577,251	708,904	907,860	907,757	1,291,884	b/
Turkeys sold	204,616	195,344	65,285	60,877	na	
Milk cows	47,854	45,876	35,968	33,154	28,434	

Source: Census of Agriculture, U.S. Department of Commerce.

a/ Commercial farms only.
b/ Three months old and over.

Volume and Value of Farm Output

The value of all farm products sold in the area in 1969 amounted to $42.7 million. Of these sales, approximately 78 percent were related to livestock and livestock products (Table 25).

The value of all crops sold ($9.4 million) represented 5.5 percent of state sales during 1969. However, the value of all livestock and livestock products sold represents 9.6 percent of the state total. During 1949, these percentages were 2.4 and 14.3, respectively. Sales of vegetables in 1969 were more than five times 1949 sales in value.

Table 25. Value of Farm Products Sold, Southwestern Washington Economic Study Area, 1949-1969

Subject	1949	1954	1959	1964	1969
	Thousands of dollars				
All farm products sold	25,129	25,988	32,144	35,116	42,683
All crops	5,428	7,429	8,138	7,926	9,384
Field crops	1,708	1,533	1,542	2,017	1,629
Vegetables	372	521	951	1,308	1,885
Fruits & nuts	1,377	3,103	3,113	2,480	3,636
Forest products & horticultural specialty products	1,971	2,272	2,532	2,121	3,635
All livestock & livestock products	19,701	18,559	24,006	27,189	33,294
Poultry & poultry products	5,643	5,357	6,435	7,094	7,933
Dairy products	9,558	9,503	10,888	13,594	16,445
Livestock & livestock products other than poultry & dairy	4,501	3,700	6,683	6,501	8,916

Source: Census of Agriculture, U.S. Department of Commerce.

a/ The changes in the value of farm products sold reflect price changes as well as physical changes.

b/ Commercial farms only.

Utilization of specialized heavy equipment is common in the timber industry of Southwestern Washington.

FOREST RESOURCES

Extent and Nature of the Resources

Of the 6.2 million acres of forest land in Southwestern Washington, over 5.5 million acres (or 89 percent) are classed as commercial forest. These lands support over 132 billion board feet (Scribner Decimal C) of standing timber, 38 percent of the state's sawtimber volume.

The principal commercial species are Douglas-Fir, western hemlock, the true firs, western redcedar, Sitka spruce and western white pine. Hardwoods of commercial value are cottonwood, red alder, and big-leaf maple.

From a timber-production standpoint, the commercial forest area is generally in a good productive condition. Only 3 percent is nonstocked. About 58 percent is sawtimber, both old-growth and mature second-growth; 17 percent, poletimber; and 22 percent, seedlings and saplings. This distribution reflects the intensive logging activities of the 1920's. About half the private ownership is in the sawtimber class, while 75 percent of the public timber is still old-growth.

Utilization

The Southwestern Washington Basin has a large and greatly diversified forest products industry. The Weyerhaeuser plant at Longview is the largest integrated wood products complex in the nation. Ports along the lower Columbia River and Willapa and Grays Harbors export over 1.7 million tons of manufactured wood products annually, in addition to some 600 million board feet of unprocessed logs. The industry is the leading employer in the manufacturing field, accounts for 10 percent of the state's total payroll, and for each employee, adds more than one additional job to other industries within the state.

In 1972, the forest industries consumed over 2.5 billion board feet of raw material. About 84 percent of this is produced in the area, the balance coming from outside sources. Raw material from out-of-area comes principally from Puget Sound, while that from out-of-state comes mostly from Oregon and British Columbia (Table 26).

LOGGING IN THE OLYMPICS

Table 26. Log Consumption in Southwestern Washington Economic Study Area, 1972 (thousand board feet, Scribner Log Rule)

County of Use	Area of Origin			Total
	SW Wash	Out-of-Area	Out-of-State	
Grays Harbor	672,077	338,147	---	1,010,224
Pacific	157,982	524	---	158,506
Lewis	223,555	10,935	---	234,490
Wahkiakum	6,315	---	---	6,315
Cowlitz	797,056	4,690	17,554	819,300
Clark	161,428	3,200	37,520	202,148
Skamania	96,282	---	1,882	98,164
Total	2,114,695	357,496	56,956	2,529,147
Percent	84	14	2	100

Source: Bergvall, John A. and Gedney, Donald R., Washington Mill Study, Wood Consumption and Mill Characteristics, 1968; a joint study by State of Washington, Department of Natural Resources and USDA, Forest Service, Pacific Northwest Forest and Range Experiment Station, June 1970.

The timber industry during the 195570 period harvested slightly over 2.6 billion board feet annually (Table 27). In the latter 1960's, influenced by the overseas raw-log market, this has increased to over 3 billion board feet per year. 9/

Ownership distribution of log production in the area is shown in Tables 27 and 28. Nearly 70 percent of the production is from private lands; the balance is mostly from state and national forest lands. Of the over 2 billion board feet average harvest from private lands in the last three years, about 1.9 billion board feet (or 88 percent) came from industrial forest holdings (Table 29). In 1972, this amounted to 63 percent of the total area harvest.

9/ Wall, Brian R., Log Production Washington and Oregon Related to National Business Conditions.

Table 27. Timber Harvest by Ownership in Southwestern Washington Economic Study Area (thousand board feet, Scribner Log Rule)

Year	National Forest	Per-cent	State	Per-cent	Other Public [a/]	Per-cent	Indian	Per-cent	Private	Per-cent	Total	Per-cent
1955	310,614	(15)	185,443	(9)	589	b/	143,421	(7)	1,459,069	(69)	2,099,136	(100)
1960	442,581	(22)	111,588	(5)	3,190	b/	96,487	(5)	1,386,282	(68)	2,040,128	(100)
1965	664,200	(21)	264,599	(8)	14,027	(1)	170,084	(5)	2,088,580	(65)	3,201,490	(100)
1970	541,878	(18)	146,030	(5)	17,370	(1)	139,333	(4)	2,214,835	(72)	3,059,466	(100)

a/ Includes timber harvest from lands administered by cities, counties, BLM, BPA, National Park Service, Fish and Wildlife Service, and military reservations.

b/ Less than 0.5 percent.

Source: Summarized from Washington Timber Harvest Reports, 1958 through 1970 by Brian R. Wall, John M. Bergen, and others. USDA, Forest Service, Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

Table 28. Timber Harvest by Ownership by County of Origin, Southwestern Washington Economic Study Area, 1972
(thousand board feet, Scribner Log Rule)

County	National Forest	State	Other Public	Indian	Private	Total	Percent
Grays Harbor	93,971	5,797	27,217	153,967	276,000	556,952	18
Pacific	------	29,500	80	------	466,674	496,254	16
Lewis	117,224	40,936	-----	------	493,674	652,155	21
Wahkiakum	------	17,180	4,771	------	111,366	133,317	4
Cowlitz	3,034	123,303	1,425	------	685,592	813,354	27
Clark	------	4,544	910	------	18,693	24,147	1
Skamania	282,806	21,158	25	------	74,425	378,414	13
Total	497,035	242,418	34,428	153,967	2,126,745	3,054,593	100
Percent	16	8	1	5	70	100	

Source: Lloyd, J. D.,1972 Washington Timber Harvest, USDA, Forest Service, Pacific Northwest Forest and Range Experiment Station, Portland, Oregon, August 1973.

Logs from public lands find their way into all segments of the industry, although federal legislation limits the amount that may be exported overseas. The Grays Harbor Federal Sustained Yield Unit on the Olympic National Forest further limits export of logs from the area. Unit regulations require that all logs produced on the Quinault District of the Olympic National Forest must receive primary manufacture in the Grays Harbor area.

Table 29. Private Timber Harvest in Southwestern Washington Economic Study Area (thousand board feet, Scribner Log Rule)

	Private		Private	All Owners
	Industrial	Other	Total	Total
1972	1,911,585	215,160	2,126,745	3,054,593
1971	2,002,328	196,119	2,198,447	2,929,775
1970	1,961,014	253,821	2,214,835	3,059,466
1969	1,861,823	302,660	2,164,483	3,170,691
1968	1,924,599	274,613	2,199,212	3,358,530
5 year average	1,932,270	248,475	2,180,745	3,114,611
Percent	88.6	11.4	100	
Percent	62.0	8.0		100

Source: Wall, Brian R., Washington Timber Harvest (1968, 1969, 1970, 1971, 1972) USDA, Forest Service, Pacific Northwest Forest and Range Experiment Station, Portland, Oregon.

ECONOMIC PROJECTIONS

The basic methodology used to derive population and employment projections was to analyze the historic trends of various economic indicators. Regression analysis was used to project population growth.[10/] Several sources were used for basic data and for purpose of comparison.

Projections provide local and regional planners with an insight as to what might happen in the future, under given assumptions, with regard to population and employment in the Economic Area. These projections are based on the general assumption that factors which have affected historical trends will continue to affect these trends in a similar manner in the future. Other assumptions include general economic stability, continued programs in research and extension, adequate marketing and transportation facilities, continued credit availability, and probability of no major wars.

Population and Employment

The population projections shown in this section of the report are slightly higher than those shown in Appendix VI, Economic Base and Projections, Columbia-North Pacific Comprehensive Framework Study of Water and Related Lands. This study used OBERS population projections, and even after adjustments were made to account for minor geographical differences for the CNP, subregions 8 and 10 North were considered too low. This study has incorporated 1970 county population data, whereas the CNP study was

10/ Preliminary Report on Economic Projections for Selected Geographic Areas, 1929 to 2020, Volume I, Water Resources Council, Washington, D.C., 1969.

Preliminary Projections of Economic Activity in the Agricultural, Forestry and Related Economic Sectors of the United States and Its Water Resource Regions, 1980, 2000 and 2020. Prepared by the Economic Research Service and Forest Service, U.S. Department of Agriculture, August 1967.

Economic Activity in the United States by Water Resources Regions and Subareas, Historical and Projected 1929-2020, Volume 4, Water Resources Council, Washington, D.C., 1971.

Economic Base and Projections, Appendix VI, Columbia-North Pacific Comprehensive Framework Study of Water and Related Lands, submitted by the Pacific Northwest River Basins Commission, Vancouver, Washington, January 1971.

limited to official 1960 data and was influenced by slow growth between the years 1950 and 1960 (see Table 30). The growth of 9,984 persons in the decade from 1950 to 1960 is much lower than the increase of 56,083 during the following decade. The resulting differences in projections of population are as follows:

Table 30. Population Projections Based Upon Adjusted OBERS and Values Used for Southwestern Washington Economic Study Area, 1970, 1980, 2000, 2020.

Type	1970	1980	2000	2020
	----------Number of Persons----------			
Adjusted OBERS	289,200	317,400	387,500	472,700
Southwestern Washington		351,900	420,800	489,800
Difference		34,500	33,300	17,100

Projections of area population and employment in other commodity- and noncommodity-producing industries form an essential environment of which agriculture is only one component. Manufacturing comprised over 37 percent of area employment during 1960 (Table 16). Noncommodity-producing industries comprised 56 percent of the area's employment. The relative importance of employment in these noncommodity-producing industries for the area and the United States is shown by Table 31.

Table 31. Employment in the Noncommodity Producing Industries for Southwestern Washington Economic Study Area & the United States, 1970.

Industry	Southwestern Washington	United States
	Percent	Percent
Contract construction	10.8	9.2
Transportation, communications and utilites	12.7	10.8
Wholesale and retail trade	28.9	28.6
Finance, insurance and real estate	4.3	6.6
Services	35.7	32.9
Public administration & armed forces	7.6	11.9
All noncommodity producing industries	100.0	100.0

Population in the Economic Study Area is projected to increase from approximately 271,000 persons in the year 1960 to 490,000 by 2020. With a projected employment-population participation rate of .398, there will be 194,940 persons employed in the area during 2020. Approximately 79 percent of these persons would be employed in manufacturing, retail trade, and services (Table 32).

Table 32. Projections of Population and Employment for Specific Employment Sectors, Southwestern Washington Economic Study Area, 1970, 1980, 2000, and 2020.

Item	: 1970	: 1980	: 2000	: 2020 :
Population	327,323	351,900	420,800	489,800
Participation rate (empl/pop)	.352	.390	.394	.398
Total employment	115,519	137,241	165,795	194,940
Agriculture, forestry, & fishery	4,717	3,367	2,695	3,450
Mining	310	213	196	181
Contract construction	7,700	8,214	7,455	6,188
Manufacturing	37,709	59,139	74,472	76,221
Transportation	5,508	6,722	8,766	11,466
Communications & utilities	---	2,839	3,852	3,905
Wholesale trade	3,292	3,586	4,100	4,712
Retail trade	18,072	18,658	25,369	33,021
Finance, insurance, & real estate	4,192	4,980	6,018	6,800
Services	25,931	28,821	31,138	44,996
Public administration & armed forces	4,638	4,000	4,000	4,000

Rural farm population in the area has been decreasing since 1930, and this decline is projected to continue throughout the projection period. It is expected that there will be only 7,690 persons comprising the rural farm population in 2020 (Table 33). In Pacific County, approximately 8 percent of the people comprised the rural farm population in 1970. Pacific County ranked 29th among Washington's 39 counties in farm population during that year, but ranked 27th in total population. Grays Harbor County had only 3.7 percent of its population classified as rural farm during 1970. Most of the rural population in that area was, and should continue to be, rural nonfarm.

Table 33. Rural Farm Population, Southwestern Washington Economic Study Area, 1940-1970, and Projections for 1980, 2000, and 2020.

Year	Number of Persons a/
1940	53,606
1950	43,606
1960	20,917
1970	18,433
1980	16,010
2000	11,870
2020	7,690

a/ Compiled from Census of Population for years 1940, 1950, 1960, and 1970.

Agricultural Projections

Agricultural projections for the Economic Study Area are based on the assumption that factors influencing historical trends will continue into the immediate future. The resulting projections are thus an aggregation of the shifting pattern of economic activity at specific points in time. Factors that affect future agricultural economy which were considered in developing the agricultural projections include the following: population growth; rising per capita income; changes in consumer tastes and their influence on per capita use of agricultural commodities; industrial and other use of agricultural commodities; livestock feeding efficiencies and composition of the feed ration; foreign markets for agricultural products; changes in crop yields; availability of the land resource. These projections are neither goals nor constraints. They represent expected economic future, based on past trends and other specific assumptions.

Crop Yields – The crop yield base data for the Economic Study Area were developed by the Soil Conservation Service for the Economic Research Service for the year 1966. Projected yields were used in the determination of cropland production for the years 1980, 2000, and 2020.[11/]

Base yields and indexes of yields, by major crops, are shown by Table 34.

11/ For a detailed discussion of the guideline assumptions furnished the Experiment Station staff, see Appendix IV, Economic Base and Projections, Columbia-North Pacific Region Comprehensive Framework Study, January 1971.

Table 34, Base Yields Per Acre and Indexes of Projected Per-Acre Yields for Selected Crops, Southwestern Washington Economic Study Area, 1980, 2000, and 2020.

Crop	Unit	Irrig. or Non-Irrig.	Base Yield 1966	Year and Yield a/ 1980	2000	2020
Rye	Bu.	NI	15.3	103	119	130
Barley	Bu.	I	74.2	106	119	125
Barley	Bu.	NI	61.4	108	116	122
Winter wheat	Bu.	I	53.6	111	139	156
Winter wheat	Bu.	NI	43.9	122	146	158
Spring wheat	Bu.	I	54.6	125	133	142
Spring wheat	Bu.	NI	55.3	121	138	148
Oats	Bu.	I	45.2	107	113	116
Oats	Bu.	NI	30.3	104	111	118
Small grains cut for hay	Tons	I	2.6	100	100	100
Small grains cut for hay	Tons	NI	1.9	111	122	133
Corn silage	Tons	I	19.7	137	184	200
Corn silage	Tons	NI	18.0	139	150	156
Alfalfa hay	Tons	I	2.8	136	170	193
Alfalfa hay	Tons	NI	2.4	109	114	118
All other hay	Tons	I	2.5	116	136	148
All other hay	Tons	NI	1.9	110	120	125
Potatoes	Cwt.	I	365.7	110	124	138
Sweet green peas	Cwt.	I	36.0	117	150	167
Sweet green peas	Cwt.	NI	30.0	120	128	140
Sweet corn	Tons	I	6.0	133	200	267
Sweet corn	Tons	NI	5.0	120	129	140

1/ Base year is 1966.

Source: Washington State University, Experiment Station staff, and Soil Conservation Service.

Fertilizer Application Rates – Explicitly related to projected changes in crop yields were projected changes in fertilizer application rates, by crop, for both irrigated and nonirrigated cropland. Pounds of nitrogen, phosphate, and potash for the years 1980, 2000 and 2020 were projected by the Washington State Experiment Station staff at the request of the Economic Research Service (Table 35).

Acreage – Projections of Cropland acres were based on several sources and factors. Historical trends of cropland for each county and the Economic Study Area were analyzed from Census of Agriculture data. The relationship between total cropland and irrigated and nonirrigated cropland was also examined. Table 36 shows the projected decrease from 1969-2000 in total cropland and projected changes in cropland pasture and hay and silage acreage. Total cropland is projected to increase between the years 2000-2020 because of increased requirements of hay and silage to support an expanding livestock and dairy industry.

Table 35. Fertilizer Applications Per Acre for Selected Crops, 1966, and Projected Fertilizer Applications for Years 1980, 2000, and 2020 for the State of Washington.

Crop	Irrigated: or non-irrigated:	Year and Pounds Per Acre											
		1966			1980			2000			2020		
		N	P	K	N	P	K	N	P	K	N	P	K
All rye	---	20-	0-	0	40-	0-	0	45-	0-	0	50-	0-	0
Barley	I	60-	10-	0	100-	30-	20	120-	30-	20	120-	20-	40
Barley	NI	40-	0-	0	40-	0-	0	50-	0-	0	55-	0-	0
Corn for grain	I	125-	25-	10	180-	30-	30	240-	45-	45	260-	60-	80
Winter wheat	I	120-	25-	10	180-	30-	30	240-	45-	45	260-	60-	80
Winter wheat	NI	45-	5-	0	50-	10-	0	65-	10-	5	70-	10-	10
Spring wheat	I	90-	30-	10	120-	30-	30	150-	30-	30	200-	40-	60
Spring wheat	NI	30-	0-	0	35-	5-	0	35-	10-	0	35-	10-	5
Oats	I	60-	10-	0	100-	30-	20	120-	30-	20	160-	40-	60
Oats	NI	30-	0-	0	35-	0-	0	40-	5-	5	40-	10-	5
Small grains cut for hay	I	60-	10-	0	100-	30-	20	120-	30-	40	180-	40-	60
Small grains cut for hay	NI	20-	0-	0	25-	0-	0	40-	0-	0	50-	0-	0
Corn silage	I	125-	25-	10	180-	30-	30	240-	45-	45	200-	60-	80
Corn silage	NI	40-	0-	0	50-	0-	0	55-	5-	0	55-	10-	0
Alfalfa hay	I	0-	40-	20	0-	50-	40	0-	50-	60	0-	60-	120
Alfalfa hay	NI	0-	20-	0	0-	25-	0	10-	25-	0	10-	30-	0
All other hay	I	40-	20-	10	80-	30-	30	100-	30-	30	120-	40-	60
All other hay	NI	8-	10-	0	10-	15-	0	10-	20-	0	15-	25-	0
Potatoes	I	200-	60-	90	240-	60-	100	270-	60-	120	300	60-	140
Sweet, green peas	I	30-	10-	10	60-	30-	30	60-	60-	60	60-	60-	80
Sweet, green peas	NI	0-	123-	300	0-	123-	300	0-	123-	300	0-	123-	300
Sweet corn	I	100-	120-	120	120-	150-	150	150-	180-	200	150-	180-	200
Sweet corn	NI	90-	100-	100	100-	120-	120	100-	120-	130	90-	120-	150
Pasture	I	50-	25-	10	60-	30-	30	80-	40-	40	80-	60-	60

Table 36. Projections of Major Uses of Cropland, Southwestern Washington Economic Study Area, 1969, 1980, 2000, and 2020.

Land Use	1969	1980	2000	2020
	----------Acres----------			
Cropland, total	233,505	265,600	262,300	281,400
Cropland pasture	113,379	114,500	119,600	122,700
Hay and silage	89,948	115,800	115,400	134,000

The volume of major crops produced in the area is projected to increase significantly. Production of all hay and silage is projected to reach 530,000 tons by 2020, which is an 81 percent increase over the 1964 production (Table 37). Production of fruits, nuts and berries is projected to increase to 67.5 million pounds by the year 2020, representing a threefold increase over 1964.

Table 37. Projections of Production for Major Agricultural Crops, Southwestern Washington Economic Study Area, 1969, 1980, 2000, and 2020.

	Unit	1969	1980	2000	2020
		----------Thousands----------			
Small grains	Tons	10.7	9.3	8.6	6.8
All hay and silage	Tons	256.4	326.0	404.7	530.2
Dry beans and peas	Cwt.	t[b/]	t[b/]	t[b/]	t[b/]
Potatoes[a/]	Cwt.	196.0	278.6	367.2	481.3
Vegetables	Tons	20.0	32.7	42.6	59.4
Fruits, nuts, and berries[a/]	Lbs.	18,394.8	37,252.0	50,628.0	67,483.0
Forage seeds and mint	Lbs.	62.7	86.0	98.0	112.0

a/ Farms with sales of $2,500 and more.
b/ Trace.

Livestock and Livestock Products – Production of livestock and livestock products is projected to increase in the area through the year 2020. Higher per capita consumption rates of beef and veal, as well as an increasing population, resulted in a projected production of 106.8 million pounds of beef and veal in 2020 (Table 38). Projected production for pork, sheep and lambs, milk, broilers, turkeys, and eggs is also shown.

Table 38. Projections of Production of Livestock and Livestock Products, Southwestern Washington Economic Study Area, 1969, 1980, 2000, and 2020.

Category	1969	1980	2000	2020
	----------Millions of pounds----------			
Beef and Veal	41.1	61.2	81.3	106.8
Pork	0.3	0.3	0.3	0.4
Sheep and lambs	0.3	0.7	1.0	1.2
Milk	238.2	301.9	378.7	488.9
Broilers	16.4	22.3	28.9	36.9
Turkeys	t[a/]	t[a/]	t[a/]	t[a/]
Eggs	23.0	34.0	44.6	57.9

a/ Trace.

The population served by the livestock and livestock products industry within the Economic Study Area is by no means limited to resident population. Adjacent to the area are the Tacoma and Portland Standard Metropolitan Statistical Areas (SMSA), which had a combined population of 1,420,000 persons in 1970. Next to the Tacoma SMSA is the Seattle-Everett SMSA which, combined with the other two statistical areas, provides a readily accessible consumptive population of over 2.8 million persons. Historically, a part of the livestock and livestock products production of the area has been transported into these three areas.

Feeding Efficiencies and Feed Rations – Washington State University Experiment Station staff was requested by the Economic Research Service to determine and project the conversion rates of various feeds into several types of livestock and livestock products. After projecting the feeding efficiencies, the Experiment Station staff projected the change in the composition of the feed ration for each livestock category. The projections reflect changes in feeding efficiency likely to result from improved technology and management.

The conversion rate for each type of livestock or livestock product was expressed in terms of feed units required to produce one pound of live-weight animal, milk, or eggs. A feed unit was defined as the feed value equivalent to one pound of corn. Composition of the ration for each livestock category was determined, and expressed as concentrates, silage, hay, high protein supplement, and pasture. Table 39 shows projected feeding efficiencies for 1980, 2000, and 2020.

Table 39. Projected Indexes of Feeding Efficiencies, in Feed Units Per Pound, for Various Livestock Categories, Southwestern Washington Economic Study Area, (1966 = 100) 1980, 2000, and 2020.

Livestock category	1980	2000	2020
Beef and veal	88	82	76
Lamb and mutton	93	86	79
Pork	86	77	69
Broilers	95	95	95
Turkeys	97	94	94
Milk	86	76	75
Eggs	97	97	90

Source: Washington State University and Oregon State University, Agricultural Experiment Station staffs.

Forest Industry Projections

The forest products industry, in terms of total earnings, is the leading manufacturing industry in the basin. In 1968, it accounted for $310 million, or 34 percent of the total manufacturing earnings. Although its share is forecast to drop to 28 percent by 2020, forest industry earnings are projected to rise to over $1.5 billion, and it will still remain the leading individual industry. 12/

12/ Economic Activity in the United States by Water Resources Regions and Subareas, Historical and Projected 1929-2020. Water Resources Council, Washington, D.C.

Wood Consumption – In 1965, the industry consumed 635 million cubic feet of wood fiber. This is projected to increase to 926 million cubic feet by the year 2020 (Table 40). Roundwood consumption by lumber, plywood, and other wood products will peak around 1980 and slowly decline toward 2020. Pulpwood requirements, influenced by the projected rising national demand for pulp and paper products, will climb steadily throughout the projection period. Industrial growth, in general, will be constrained to some extent by projected limitations on the available wood supply.

Table 40. Wood Consumption in Southwestern Washington Economic Study Area with Projections to the Year 2020.

Date	Wood Consumption		
	Lumber and Wood Products	Pulp and Paper	Total
	(million cubic feet)		
1965	369	266	635
1970	389	281	670
1980	425	379	804
2000	400	552	952
2020	322	604	926

Source: Wall, Brian R., Projected Developments of the Timber Economy of the Columbia-North Pacific Region, USDA, Forest Service, Pacific Northwest Forest and Range Experiment Station, Portland, Oregon, February 1969.

During the projection period, changes in major land use are expected. Forest land areas are projected to decrease by 1.5 percent from 1965 levels. [13/] Greatest loss is expected from urban sprawl and increased recreation area reservations. Environmental restrictions may also affect the harvest from the remaining commercial base.

Employment and Income - Detailed employment and income projections were made for Southwestern Washington, based on trend relationships of employment and wood consumption by SIC Code. These are shown by Table 41.

Table 41. Forest Industry Employment, Southwestern Washington Economic Study Area.

Type	1965	1980	2000	2020
	(Number of persons)			
Lumber and Wood Products	17,760	13,792	11,591	9,558
Pulp and Paper	8,813	9,228	9,752	8,368
Forest Management[a/]	2,590	4,461	6,452	7,512
Totals	29,163	27,481	27,795	25,438

Source: Wall, Brian R., Projected Developments of the Timber Economy of the Columbia-North Pacific Region, USDA, Forest Service, Pacific Northwest Forest and Range Experiment Station, Portland, Oregon, February 1969.

a/ Forest management includes all workers, both publicly or privately engaged in the protection and management of forest lands for the production of timber and related products. It includes part-time employees converted to an equivalent full-time basis.

Total forest industry employment is projected to decline about 13 percent during the 1965-2020 period. This compares to a projected 37 percent decrease for the Columbia-North Pacific Region as a whole. Employment in lumber and wood products is projected to drop the most, due to increased employee productivity coupled with reduced wood consumption. Employment in pulp and paper will hold fairly constant as increased wood consumption demands will be offset by improved employee productivity. Only forest management will show a significant increase in employment -- 190 percent during the 1965-2020 period. This is understandable, as greater productivity requirements placed on the forest resource will require more people in the management field.

13/ Appendix VIII, Columbia-North Pacific Type I Study, May 1971.

In 1962, worker incomes in all forest-related activities amounted to nearly $154 million. Workers in the lumber and wood products industry received 57 percent of the total, those in pulp and paper received 34 percent, and forest management employees received 9 percent. Between 1962 and 2020, total payrolls in the forest economy are projected to increase 163 percent, to a total of $405 million. This will be due to increased wood consumption and improved employee productivity, even though the total number of employees will decline. (Table 42).

Table 42. Income (Payrolls) in the Forest Products Industry, Southwestern Washington Economic Study Area.

Type	1962	1980	2000	2020
	(Thousand dollars)			
Lumber and Wood Products	88,009	104,900	107,844	98,804
Pulp and Paper	52,848	93,740	136,313	149,159
Forest Management	12,906	34,775	82,388	157,234
Total	153,763	233,415	326,545	405,197

Source: Wall, Brian R., Projected Developments of the Timber Economy of the Columbia-North Pacific Region, USDA, Forest Service, Pacific Northwest Forest & Range Experiment Station, Portland, Oregon, February 1969.

The Southwestern Washington Economic Study Area has a large timber resource and a large forest industry based on that resource. The manufacture of pulp, paper and allied products will replace lumber and other wood products as the leading consumer of raw material. While continued growth can be expected, it will be at a much slower rate, and employment can be expected to decline. Wood consumption in the area is presently in balance with raw material production. Consumption is projected to increase consistently through 2020, however, and then tend to level out. This increase, coupled with a slightly decreasing forest land base, will require increased productivity from the remaining forest areas. Productivity increases can be met by accelerated reforestation, improved utilization, and better access. This will require more emphasis on watershed protection and erosion control programs, particularly in connection with selective logging and road construction. This impact will also require coordinated land and water resource development planning and more realistic consideration of the multiple or overlapping uses of the forest base.

IMPACTS OF LAND USE CHANGES

An analysis of historic trends, the projected needs for future types of land use, and review of data from other studies, resulted in the determination of future use of lands and resources in the Southwestern Washington Basin. These shifts are shown in Table 43.

Based on analysis of cropping patterns, projected future requirements for food production, and the best estimates of what farmers can be expected to cultivate, total cropland is projected to decrease 28 percent, or slightly over 100,000 acres, by the year 2020. Although total area harvested will decrease, local fresh produce will remain steady, and with increased yields will increase to the extent that local consumption will not be impacted. Much of the cropland will be lost to urban expansion in the Vancouver area, although some cropland will revert back to forested area through acquisition of old farm land by tree-growing companies. Some cropland is also going into production of minor forest products, such as Christmas trees.

Total forest land in the Basin should decrease by 2020, but only by 2 percent. This is due to a combination of things. About 200,000 acres will be lost to permanent roads, landings, and other timber harvest activities, powerlines and water storage projects, and urban expansion. This will be offset to some extent by reforestation of cropland areas, so that the net loss will be about 120,000 acres.

Permanent pasture can be expected to remain about as it is. Much of this land is located in stringer valleys along the flood plain, and, as such, is restricted from more intensive uses. Should future increases in crop production be required, this area could furnish some of the land supply.

"Other" land includes both barren areas and areas of intensive development in cities, suburban areas, and individual farmsteads. Barren areas can also be expected to remain constant; the major change will be in the urban, built-up, and developed land use categories. This "built-up" area can be expected to increase 67 percent from 330,000 to 550,000 acres by the year 2020. As mentioned in preceding paragraphs, this will occur on areas previously used for producing crops and growing forest products.

The "shrinking" of Southwestern Washington from 7.02 million acres today to 7.01 million acres by the year 2020 is due primarily to land inundation by water storage projects. Some land losses are also occurring from river-bank and beach erosion on lands presently used for agriculture or other intensive uses.

Table 43. Present Land Use with Projections for 1980, 2000, & 2020, Southwestern Washington Area.

	1969	1980	2000	2020
	(1000 acres)			
Cropland	376	325	285	270
Forest Land	6,237	6,190	6,170	6,115
Pasture	77	75	75	75
Other	330	430	485	550
Total	7,020	7,020	7,015	7,010

OUTDOOR RECREATION

The Southwestern Washington Basin contains a wealth of natural and scenic beauty. From the beaches, estuaries, and low-lying hills in the southernmost corner of the Basin to the river valleys, grassy prairies, upland plains, and forest-covered mountains to the east, numerous outdoor recreation activities are available. Combinations of land, water and vegetation are in marked contrast to those found east of the Cascade Mountains. The coastal area provides fishing, swimming, boating, clamming, and oyster gathering. The mountain forested areas provide vast opportunities for all forms of water-related activities, as well as hunting, camping, hiking, and general sightseeing. Figure 8 provides information on the location of recreation sites in Southwestern Washington.

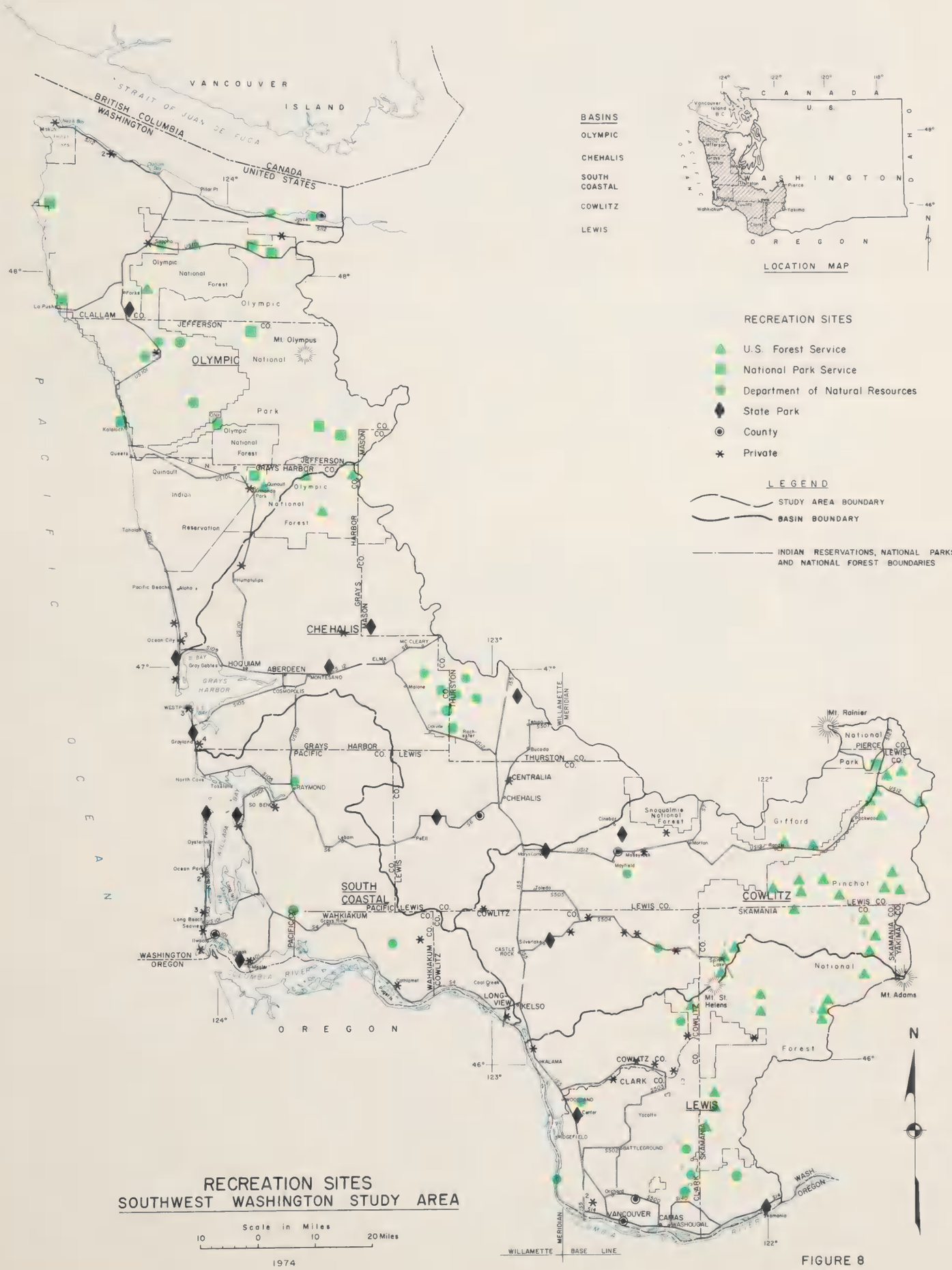
Public Recreation

The principal public agencies administering recreational lands for recreation in Southwestern Washington include the U.S. Forest Service and National Park Service, the State Parks and Recreation Commission and the State Department of Natural Resources. County and municipal governments are also involved to some extent in this endeavor.

The largest areas under Federal administration are portions of the Olympic and Gifford Pinchot National Forests. Nearly 1.3 million acres are available for some form of recreation. Included are 55 sites with over 550 acres developed for high-intensity uses, such as camping, picnicking, swimming, and boat launching. Nearly all of the 1.3 million acres are available for such dispersed uses as hunting, fishing, hiking, and general sightseeing.

About 80,000 acres of Goat Rocks and Mount Adams Wildernesses, and another 57,000 acres of Wilderness Study Area, are situated in the area. These segments of the National Wilderness Preservation System are available for visitors seeking a wilderness experience. Other areas in the national forests have been set aside for summer homes, resorts, and other public accommodations. In 1970, total recreation use on the national forests amounted to 820,000 visitor-days.

The second largest area under Federal jurisdiction are portions of Olympic and Mount Rainier National Parks. They encompass almost 580,000 acres and are available for all forms of developed and dispersed recreation. Included are 45 miles of wild and undeveloped ocean beach, deep evergreen forests, and ice fields and mountain meadows. A good part of both of these national parks has been recommended for inclusion in the National Wilderness System. Developed areas



RECREATION SITES
SOUTHWEST WASHINGTON STUDY AREA

FIGURE 8

include 11 campgrounds, resorts, and other public service sites. The National Park Service also administers national historical sites in the Basin. In 1970, total use of land administered by the National Park Service was over 3.9 million visitor-days.

Other federal lands in the Basin include those administered by Bureau of Land Management, Fish and Wildlife Service, and National Marine Fisheries Service.

These include fish rearing facilities, waterfowl refuges, hunting areas, and small parcels of public domain. Most of these areas are open to some form of outdoor recreation, including hunting, hiking, viewing wildlife, and general sightseeing. Total use on these lands in 1970 amounted to 325,000 visitor-days.

Over 1.3 million acres of state-owned lands exist in the Basin, including state parks under the administration of the Parks and Recreation Commission, wildlife areas under the Game Department, and large holdings of state timber land under the jurisdiction of the Department of Natural Resources. All of these areas are available for camping, picnicking, water sports, hunting and fishing, and other outdoor activities.

The State Parks and Recreation Commission manages 15 state parks, including ocean beaches along the south coast, forested campgrounds in the foothills, and a marina on the Columbia River. These areas are usually well developed--include flush toilets, trailer hook-ups and other facilities. Hunting, fishing, and hiking opportunities are available nearby.

The Department of Natural Resources administers a large portion of the 1.3 million acres of state ownership in the Basin. Except in periods of extreme fire danger, these lands are open for hunting, fishing, and hiking. To accommodate the recreationists, the Department has developed 28 campgrounds with picnic sites within their holdings.

The Washington State Departments of Fisheries and Game maintain 26 hatchery and rearing areas, and five waterfowl and big game hunting areas available for outdoor recreation. Total recreation use on all state-owned and managed lands within Southwestern Washington amounted to nearly 4.2 million visitor-days in 1970.

County and municipal governments also furnish recreation facilities in the Area. They include county park and picnic sites, city parks, and water related developments, around two Tacoma City Light power projects on the Cowlitz River. County and city parks usually provide day-use facilities, a very important service near urban areas. Most of the facilities on the Cowlitz reservoirs are still in the development stage. They will include both overnight and day-use areas. In 1970, nearly 800,000 visits were made to these county-municipal sites in Southwestern Washington.

Private Recreation

Private recreational facilities in the area center around lodging, marinas, reservoir sites, and campgrounds furnished by the major timber companies. Lodging and marina services are concentrated in Grays Harbor, Clark and Cowlitz Counties (Table 44). Water-based recreation opportunities on developed reservoirs are furnished by the Pacific Power and Light Company and are concentrated on three power projects in the Lewis River drainage. Recreational facilities on these reservoirs include four picnicking areas, two campgrounds, and resort and summer home areas. The timber companies have developed both overnight and picnic areas throughout their holdings in the area. Developments are more primitive in nature, but do furnish tables, fireplaces, sanitary facilities, and water.

Total use at privately-developed recreational facilities in Southwestern Washington amounted to 3.7 million visitor-days in 1970.

Table 44. Private Recreation Facilities, By County, Southwestern Washington Economic Study Area, 1966

Type of Facility	Clark	Cowlitz	Grays Harbor	Lewis	Pacific	Skamania	Wahkiakum	Total
	Number of facilities							
Lodging:								
Cabin cottages	0	0	3	0	7	2	2	14
Vacation farms, ranches	1	0	1	1	0	0	0	3
Trailer parks	12	2	23	4	8	4	4	57
Resorts	1	8	46	4	1	4	0	64
Camping	0	9	6	0	0	2	3	20
Organized youth camps	6	10	7	0	1	8	0	32
Organized adult camps	0	0	1	0	0	0	1	2
Active sports:								
Hunting	0	0	0	1	0	0	8	9
Shooting	1	0	1	0	0	0	0	2
Skiing, winter sports	0	0	0	1	0	0	0	1
Public golf	2	0	3	2	2	0	1	10
Par 3 golf, driving range	2	1	0	0	0	0	0	3
Horseback riding	1	1	3	1	0	1	2	9
Archery	1	0	1	0	0	0	0	2
Picnicking and water activities:								
Picnic area only	0	0	2	0	0	0	0	2
Picnic, other facilities	2	10	6	0	0	3	6	27
Water, several activities	2	8	0	0	0	3	12	25
Water, swimming only	1	1	0	0	0	0	0	2
Water, boating only	0	2	0	0	0	0	0	2
Marinas, moorage	14	6	35	1	11	0	1	68

Washington Statewide Outdoor Recreation and Open Space Plan, page 43.

Farm Income – Revenue derived by Southwestern Washington farmers from recreational services decreased substantially during the period 1964-1969. Clark County farms accounted for 52 percent of this income in 1964, but dropped to approximately 21 percent by 1969 (Table 45). Cowlitz County was the only county to report an increase in farm-related income from recreational services during this 5-year period.

Table 45. Farm-related Income from Recreational Services, Southwestern Washington Economic Study Area, 1964 and 1969.

County	1964	1969
	----------Dollars--------	
Clark	29,775	6,958
Cowlitz	3,855	10,675
Grays Harbor	3,381	3,110
Lewis	14,226	8,729
Pacific	5,950	4,320
Skamania	------	------
Wahkiakum	(D)	100
Total	57,187	33,892

Census of Agriculture, U.S. Department of Commerce, 1969.

Retail Sales - Taxable retail sales concerning those industries related to recreation were studied to determine the impact of such expenditures on the area. In Washington State, retail sales data prior to April 1970 do not accurately reflect the entire retail business being transacted within a county. County figures are somewhat understated, since the location of a firm's headquarters office may be outside the county. However, for most of the firms supplying items to persons participating in outdoor recreation, this difference appears small. County taxable retail sales for relevant Standard Industrial Classifications appear in Table 46. During 1970, Clark County had about 30 percent of total sales for the 10 relevant SIC sectors.

Table 46. County Taxable Retail Sales, 10 Standard Industrial Classification Sectors, Southwestern Washington Economic Study Area, 1969, 1970, and 1971.

County	1969	1970	1971
	----1,000 dollars---		
Clark----------	19,959	22,940	25,030
Cowlitz----------	14,391	14,526	14,463
Grays Harbor----------	21,358	20,856	21,009
Lewis----------	10,998	12,010	13,007
Pacific----------	4,744	4,954	5,534
Skamania----------	563	544	586
Wahkiakum----------	481	508	573
Total	72,494	76,338	81,272

Department of Revenue, State of Washington.

During 1970, retail sales for the 10 sectors totaled $76.3 million, or around $2,332 per resident. For the entire state, the equivalent figure for 1970 was approximately $1,390. This differential in taxable per capita sales is not necessarily derived from the presence of an abundance of outdoor recreational opportunities. Table 47 lists the sources of retail sales. About 57 percent of the $76.3 million came from sales at eating and drinking places. Much of these sales could represent local resident purchases, combined with normal business pattern consumption. It is difficult to determine whether sales at gasoline service stations (the second largest item listed in Table 47) were made to local residents or to tourists.

Table 47. Taxable Retail Sales, 10 Standard Industrial Classification Sectors, Southwestern Washington Economic Study Area, 1970.

Industry	1,000 dollars
Gasoline service stations	10,341
Eating and drinking places	43,904
Sporting goods stores	3,107
Souvenir or gift stores	4,867
Hotels/motels/tourist courts	7,706
Tourist homes	----
Travel parks and camps	461
Movie theaters	39
Bowling alleys	1,671
Bathing beaches/golf courses & misc. services	4,242
Total	76,338

Compiled by the Economic Research Service from Department of Revenue data.

In an effort to relate camping sales with local sales, state revenue data were studied on a quarterly basis for each industry. Since 95.4 percent of the sampled overnight camping was conducted between April and the end of September, retail sales should reflect some significant changes. Quarterly taxable retail sales for the above industries were as follows:

January through March---------- $15.2 million

April through June---------- $19.4 million

July through September---------- $23.9 million

October through December---------- $17.8 million

Table 48 shows the percentage breakdown of sector sales for the area, by quarter.

Table 48. Quarterly Taxable Retail Sales, by Industry and Percent, Southwestern Washington Economic Study Area, 1970.

Industry	January-March	April-June	July-September	October-December
	Percent			
Gasoline service station	15.1	13.4	11.9	14.6
Eating & drinking places	59.6	57.8	55.0	58.6
Sporting goods stores	3.7	5.0	3.4	4.1
Souvenir or gift stores	6.0	6.2	5.1	8.6
Hotels/motels/tourist courts	8.2	10.1	13.2	7.6
Tourist homes	----	----	----	----
Travel parks & camps	0.3	0.6	0.8	0.6
Movie Theatres	1/	0.1	0.1	1/
Bowling alleys	3.4	1.7	1.1	3.2
Bathing beaches/golf courses & miscellaneous services	3.7	5.1	9.2	2.7

Compiled by the Economic Research Service from Department of Revenue data.

1/ Less than one-tenth of 1 percent.

Seasonality - About 82 percent of overnight camping in the area during 1970 occurred during June, July, and August (Table 49). August was the highest month, with 32.3 percent of the yearly total.

Table 49. Percentage of Persons Camping Overnight, By Month, Southwestern Washington Economic Study Area, 1970.

Month	Percent
January----------	0.2
February----------	0.7
March----------	1.8
April----------	1.5
May----------	5.3
June----------	18.6
July----------	31.1
August----------	32.3
September----------	6.6
October----------	1.4
November----------	0.4
December----------	0.1
Total------	100.0

Compiled by the Economic Research Service from Washington State Department of Fisheries data.

Salmon Sports Fisheries – A major recreational activity in the Economic Study Area is sports angling for coho, chinook, and pink salmon. Private and charter boats in the Ilwaco and Westport-Ocean Shores areas accounted for 38 percent of the 968,395 sports salmon caught within the state during 1970. During that year, fresh water and salt water sports fishing in the area accounted for approximately 68 percent of the state's salmon catch.

Each year, thousands of area residents secure the required Sport Salmon Catch Record card to record the date and location of their salmon catch. These records are returned to the Washington State Department of Fisheries, which tabulates and publishes the results. During 1970, approximately 67,000 area residents angled for salmon (Table 50). Twenty-one percent of the area's population obtained catch record cards, which is a much higher rate than the state average of 11.8 percent.

Table 50. Number of Area Anglers and the Percent of Population Angling, by County, Southwestern Washington Economic Study Area, 1970.

County	Number of Anglers	Percent of Population
Clark	24,100	18.8
Cowlitz	17,800	25.9
Grays Harbor	11,925	20.0
Lewis	7,025	15.4
Pacific	3,450	21.8
Skamania	1,400	23.9
Wahkiakum	1,475	41.1

Compiled by the Economic Research Service from Washington State Department of Fisheries data.

Most persons fishing for salmon in the area during 1970 were residents of the State of Washington. However, thousands of salmon were caught by out-of-state residents. Residents of the Pacific States, including Alaska and Hawaii, caught 605,234 salmon, or approximately 90 percent of the sports salmon catch (Table 51). Persons residing in the Mountain States accounted for an additional 5 percent of the catch.

Table 51. Number of Sports Salmon Caught, by Region of Residence, Southwestern Washington Economic Study Area, 1970.

Region	Number of Salmon
New England	477
Middle Atlantic	1,028
East Northcentral	4,500
West Northcentral	10,143
South Atlantic	1,982
East Southcentral	404
West Southcentral	2,570
Mountain	36,567
Pacific	605,243
Foreign	955
Unknown	6,548
Total	670,417

Compiled by the Economic Research Service from Washington State Department of Fisheries data.

WATER AND RELATED LAND RESOURCE PROBLEMS AND NEEDS

WATER AND RELATED LAND RESOURCE PROBLEMS AND NEEDS

EROSION AND SEDIMENT PROBLEMS

Serious soil erosion usually results from exposing bare soil to runoff water, or to winds affecting dunelands adjacent to beaches. Burning, excessive grazing, road construction, logging, urban development, and excessive tillage destroy or weaken the vegetative cover and make soil susceptible to erosion.

Construction activities expose bare earth to wind and water erosion. This road cut near Montesano has eroded badly as a result of rainfall on unvegetated soils.

Erosion Hazards

Approximately 97 percent of the total land area of Southwestern Washington has a potential water erosion problem, if vegetation is stripped and soils are left bare, with nearly 78 percent classified as severe or very severe. Fortunately, most lands are adequately protected with vegetation. Table 52 gives the extent of water erosion hazard classes by subbasins for Southwestern Washington. Table 53 displays extent of erosion hazard classes by five broad land use categories. This tabulation indicates that about 90 percent of land with slight, moderate, severe, or very severe erosion hazards are presently in forest. Impacts of erosion are greatly reduced by this fact, affecting primarily about 100,000 acres on which vegetation is distrubed each year.

Erosion rate is a measure of soil detached from a site, and is usually indicated in tons per acre. On sites having an erosion hazard, but with vegetation undisturbed, rates of erosion average about 1.0-2.0 tons per acre annually. If vegetative cover is removed, erosion rates may average 10-20 tons per acre, with rates on sites with severe or very severe hazards being even higher. An allowable erosion rate agreed to by participants in this study is 3-5 tons per acre, depending on depth of soil to bedrock.

USDA agencies have estimated that annually about 10,000 acres of land on which vegetation is disturbed exceed minimum allowable erosion rates, and should, therefore, receive the highest priority for control measures. Of these, 85 percent are forest lands temporarily exposed to rainfall erosion during road construction and timber harvesting, and 15 percent are urban and agricultural lands.

Streambank Erosion

Streambank erosion usually occurs when streambank materials become saturated and sediments begin to move. Often the water reaches an erosive velocity when it is well below the top of the streambank. The water undercuts or erodes away the lower portion of the bank, leaving the upper portion unsupported. This upper portion then sloughs off into the water. This is a repetitive process which leads to a sizable loss of land over a period of years in some areas, and deposition and additions to land in other areas.

Table 52. Erosion Hazard Classes for Southwestern Washington, by Subbasin.

(in acres)

Class [a]	Olympic	Chehalis	South Coastal	Cowlitz	Lewis	Total
None	29,724	104,148	26,747	44,420	30,098	235,137
Slight	140,891	299,089	72,366	91,548	100,686	704,580
Moderate	174,131	86,347	7,535	164,386	184,742	617,141
Severe	1,396,888	1,205,367	784,580	1,211,453	770,095	5,368,383
Very Severe	---	---	---	62,060	32,869	94,929
Total	1,741,634	1,694,951	891,228	1,573,867	1,118,490	7,020,170

a/ Relative terms applicable only in relation to other soils in the area.

Source: River Basin Planning Staff.

Table 53. Erosion Hazard by Land Use, Southwestern Washington

Hazard Class	Forest	Land in Agri-culture	Rural Nonfarm	Built-up	Barren, Other	Total
			Acres			
None	111,247	42,228	2,960	13,192	65,510	235,137
Slight	421,918	210,262	11,092	50,464	10,840	704,576
Subtotal	533,165	252,490	14,052	63,656	76,350	939,713
Percent Total	8.5	55.7	37.4	59.7	41.9	13.4
Moderate	502,672	86,379	10,731	13,898	3,461	617,141
Percent Total	8.1	19.0	28.6	13.0	1.9	8.8
Severe	5,110,980	114,170	12,789	29,117	101,327	5,368,383
Very Severe	90,270	-	-	-	4,659	94,929
Subtotal	5,201,250	114,170	12,789	29,117	105,986	5,463,312
Percent Total	83.4	25.3	34.0	27.3	57.2	77.8
Total	6,237,087	453,039	37,572	106,671	185,797	7,020,166

Source: River Basin Planning Staff.

Eroding river bank approximately 1000 feet in length undermines garage during high water.

For this study, streambank erosion has been broken down into two classes--moderate and serious. The definition of each follows:

1. Moderate: Small, scattered sections of each mile of streambank are affected by erosion. Damages are generally localized.

2. Serious: Large sections per mile of streambank are seriously eroded. Damages are both localized and downstream.

In 5 months, beach erosion has advanced several feet inland and seriously threatens this property. Protection is expensive, and is often byond the means of individual landowners.

All of the subbasins in this study area are affected by streambank erosion. Approximately 2,050 miles of streambank have been classified as having moderate erosion problems, and 805 miles as having serious erosion problems, throughout Southwestern Washington. For a more complete breakdown of areas with streambank erosion, see the Erosion Problems and Needs section for each subbasin.

Beach and Shore Erosion

Another type of erosion that affects certain areas along the Pacific Coast, the Strait of Juan de Fuca, and the Columbia River, is shore and beach erosion. This type of erosion is the result of such forces as gravity, tidal exchange, tidal currents, and wind waves.

Beach and shore erosion is classified as either serious or moderate. Seriously eroding shorelines are damaging or threatening private and public property and need some type of treatment to alleviate or prevent those damages. Moderately eroding shoreline poses a future threat to private and public property and will need treatment within 10-20 years.

There are over 400 miles of coastline, harbors, and Columbia River shoreline on which an erosion hazard exists. Of this 400 miles of shoreline, 45 miles have been identified as having a serious erosion problem and 45 miles as having a moderate erosion problem.

Sedimentation

Material detached and moved from the soil body is the product of erosion and is known as sediment. Sediments naturally move by relatively slow processes of alternating transportation and deposition until they reach well-defined channels where transportation by flowing water becomes a dominant feature. Channel sediments vary widely in speed of movement downstream, depending on the transporting ability of the flowing water. Some sediment is stored in channel bars or an alluvium on the flood plain.

Suspended sediments damage pumps, irrigation, and industrial equipment, and pollute the water in a variety of ways that affect the environment and detract from many of the useful purposes of the water. Sediment loads transported by floodwaters frequently are deposited on valuable farmland, creating short-term reduction in crop yields and depressing property values and incomes from businesses. Sediment often damages drainage structures and spawning beds and food-producing areas for fish, adversely affects recreation and esthetic values, causes loss to navigation facilities and other improvements, and changes estuarine areas.

Sediment yields in the area average about .01-.02 acre-foot per square mile per year in those areas with vegetative cover in place. In watersheds where cover has been disturbed or removed, the average may increase to 1.0-2.0 acre-feet per square miles per year, with actual rates much higher on the disturbed sites. Damages from sediment average over $1 million per year in Southwestern Washington.

Erosion and Sediment Reduction Needs

Areas where erosion is above 3-5 tons per acre per year allowable loss should receive highest priority for erosion control treatment. Most areas with vegetative cover intact are well below allowable erosion rates except where streambank erosion is occurring. Although logging practices contribute to erosion, the principal source of sediment originating from forest lands is logging road construction.

Erosion and resultant sediment and pollution problems result from improperly designed logging roads. The principal source of sediment in Southwestern Washington is from logging road construction.

Because most of the area's cropland is in either hay or pasture, erosion on these lands is not significant areawide. Scattered locations of streambank erosion exist in Chehalis and Lewis subbasins, and constitute a source of sediment.

All subbasins except Olympic have some erosion problems on land being converted to urban use. These problems are most extensive around Vancouver, Longview-Kelso, Aberdeen-Hoquiam, and Chehalis-Centralia--larger urban areas of the Basin.

Typical of erosion which occurs on urban lands is this housing development scene. Siltation fills road ditches and contributes to pollution of streams.

Of approximately 100,000 acres on which vegetative cover is disturbed every year, about 10,000 acres of forest, agricultural and urban lands exceed allowable erosion rates and urgently need treatment. Control and reduction of erosion will largely control adverse effects of sedimentation by reducing sources of sediment supply. Land on which vegetation is disturbed annually is expected to remain fairly constant throughout the foreseeable future.

All streambanks that are classified as having a serious erosion problem need treatment by 1980 because of the regional nature of damages that are being caused from this erosion. Those banks with a moderate problem will need treatment between 1980 and 2000 as the localized damages that exist eventually become regional damages. By 1980, portions of 810 miles of streambank will need treatment; and from 1980-2000, 2,050 miles will need treatment. A total of 2,860 miles need some type of treatment by the year 2000.

Treatment is needed on those beach and shore areas where serious and moderate erosion have been identified. Local USDA technicians have estimated that approximately 45 miles of shore and beach areas have serious erosion problems which need to be treated by 1980, and 45 miles have moderate erosion problems that will need to be treated before the year 2000. These estimates need to be confirmed by additional problem inventories, as well as studies to evaluate the feasibility of mitigation.

Additional Studies Needed

Streambank erosion has been identified fairly well on the lower reaches of the streams. However, in steep, forested areas which are not easily accessible, information is not complete. Thus, comprehensive studies documenting all areas with streambank erosion problems are needed. An inventory conducted in Grays Harbor County is an example of in-depth studies needed throughout the Basin.

There is need for an inventory of beach and shore erosion problems. There are many areas, especially in the Olympic subbasin, where information on this type of erosion is lacking. For this reason, inventories of beach and shore erosion as well as evaluations of feasibility of mitigation are needed in the Olympic, Chehalis and South Coastal subbasins.

About one-third of the average annual monetary damages attributed to floodwaters in Southwestern Washington afflicts rural property, including nonfarm residences and agricultural land and crops.

FLOODWATER PROBLEMS

Floodwater is surface accumulations of water, usually of a damaging nature, resulting from overflow, abnormally high precipitation, wind and tidal effects, or any combination of these.

There are two distinct types of floods in Southwestern Washington. The first type occurs during the spring season and is a result of melting snow on the upper reaches of a river or stream system. Most of the major rivers in the area are subject to high flows from spring snowmelt, but rarely will major overbank flooding occur as a result. Increased flows from Lewis and Cowlitz Rivers and other streams in the southern portion of the Basin contribute to high water in lower reaches of Columbia River.

Winter flooding occurs on all major river systems in the Basin. This flooding is the result of prolonged rainfall, or rainfall augmented by snowmelt. Many times, flooding on Chehalis and Willapa Rivers, and on other streams along the coast, is accompanied by high tides at their outlets. These high tides prevent water from discharging adequately and compound flooding problems on lower reaches of rivers and streams.

Winter floods frequently cause damage to those homes, industries, and farms which are constructed on flood plains.

Floodwater Hazard Classes

Areas subject to floodwater hazards have been determined from soil interpretations, by consideration of historical records and visual inspection. All land areas have been placed within four floodwater hazard classes. These classes are described as follows:

0. None: No floodwater hazard.

1. Slight: Floodwater damage may occur one year in 10 at a maximum. Usually the frequency of flooding will be considerably less than one year in 10.

2. Moderate: Floodwater damage may be expected during certain months of unusual meteorlogical conditions one year in five to 10.

3. Severe: Floodwater damage occurs one year in five at a minimum. Damage occurs regularly during certain months of the year.

Table 54 gives floodwater hazard classes by subbasins for Southwestern Washington.

Table 54. Flood Hazard Classes for Southwestern Washington, by Subbasin.

Class	Olympic	Chehalis	South Coastal	Cowlitz	Lewis	Total
			Acres			
None	1,580,490	1,417,391	794,997	1,407,167	1,020,764	6,220,809
Slight	28,380	9,399	13,279	76,843	31,776	159,677
Moderate	13,890	18,430	24,748	20,946	24,725	102,739
Severe	118,874	249,731	58,204	68,911	41,225	536,945
Total	1,741,634	1,694,951	891,228	1,573,867	1,118,490	7,020,170

Source: River Basin Planning Staff.

All land areas in Classes 1, 2, and 3 (above) flood once every 100 years on an average, or more frequently. Degree of damage depends on use of the land and duration of flooding. Land presently used for pasture might not be damaged by flooding; however, if its use is changed to residential and equivalent flood conditions recurred, damages might be severe.

Floodwater damage can also vary on the same land use, depending on crop type and season of flooding on agricultural lands, and depth of flooding and type of residential or business property on urban lands. Differences in climate and precipitation have less effect than do differences in land use and soil and topographic characteristics.

Urban flooding, typical of certain areas of the Chehalis Subbasin during some years.

Approximately 800,000 acres in the Basin could flood at least once, on an average, during a 100-year period. Table 55 gives a breakdown of floodwater hazard classes by land use for Southwestern Washington. The highest percentage of lands with a severe flood hazard by land use are: "Other" (beach and tidelands), cropland, pasture, "built-up" and rural nonfarm lands. The position of these lands in relation to flood plains and coastal areas accounts for the severity of flood hazards in most cases.

Areas where flooding causes the greatest damage include flood plains of the Chehalis River and its tributaries, Willapa River, Cowlitz River and its tributaries, and Lewis River. Many minor streams also damage smaller communities and towns throughout the Basin.

Flooded areas are located on flood plains of rivers and streams, in lowland areas along the coast, and in upland depressional areas. A general location map of areas subject to flooding in Southwestern Washington is shown in Figure 9.

Table 55 . Land Use by Flood Hazard Classes, Southwestern Washington, 1969.

Land Use	Classes					Total
	None	Slight	Moderate	Severe		
	Acres					
Commercial Forest	5,061,951	128,738	51,435	291,841	(5%)	5,533,965
Noncommercial Forest	268,340	2,194	2,530	4,191	(2%)	277,255
Reserved Forest	408,682	8,737	100	8,348	(2%)	425,867
Cropland	208,216	13,144	32,202	122,491	(33%)	376,053
Pasture	51,931	1,464	5,010	18,581	(24%)	76,986
Rural Nonfarm	29,004	485	1,093	6,990	(19%)	37,572
Built-up Lands	72,165	3,180	8,069	23,257	(22%)	106,671
Barren Lands	114,405	1,687	2,078	8,325	(7%)	126,495
Other	6,115	48	222	52,291	(88%)	59,306
Total	6,220,809	159,677	102,739	536,945		7,020,170

Source: River Basin Planning Staff.

U. S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

BASINS

OLYMPIC

CHEHALIS

SOUTH COASTAL

COWLITZ

LEWIS

LOCATION MAP

FLOOD PROBLEM LEGEND

- NONE
- SLIGHT
- MODERATE
- SEVERE
- CLASSIFICATION BOUNDARY

LEGEND

- STUDY AREA BOUNDARY
- BASIN BOUNDARY
- 0-84 WATERSHED NUMBER & BOUNDARY
- INDIAN RESERVATIONS, NATIONAL PARKS AND NATIONAL FOREST BOUNDARIES
- TOWNSHIP & RANGE LINES
- LAKES & RESERVOIRS
- SMALL RIVERS & STREAMS
- SALT WATER & LARGE RIVERS

GENERALIZED FLOOD PROBLEM MAP
SOUTHWEST WASHINGTON STUDY AREA

FIGURE 9

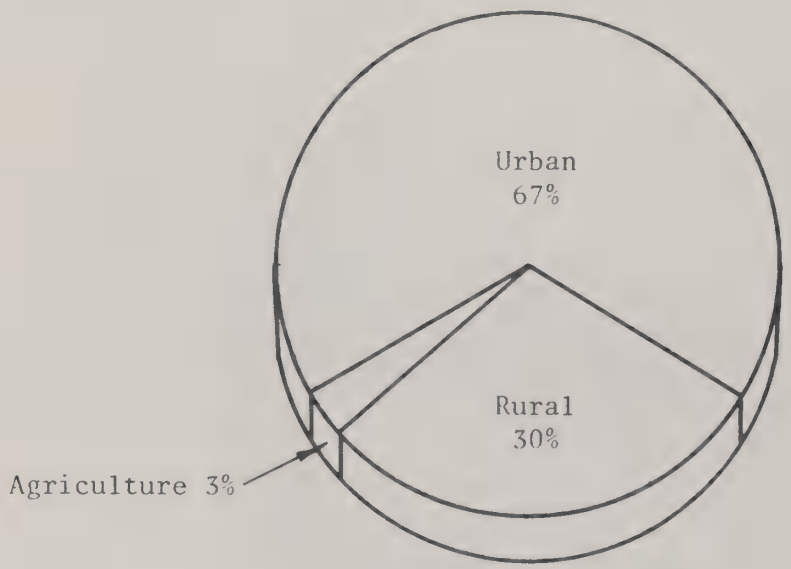
About two-thirds of the average annual monetary damage attributed to floodwaters in Southwestern Washington occurs on urban lands.

Floodwater Damages

Floodwater damages can be grouped into three general categories: urban, rural, and agricultural. Urban damages include direct damage to businesses and homes, including contents; and damages to city streets, bridges, storm sewers, and sanitation facilities. Other damages include loss of business and salaries, and flood-proofing and cleanup expenses. Rural damages include the same types of damage as for urban, only these damages are found outside the boundaries of an incorporated city or town. Agricultural damage from flooding includes damage to harvested crops and pasture, fences, machinery, and livestock. Because most flooding occurs during winter, agricultural damages are mainly limited to sediment deposition on cropland and fence and machinery damage.

Average annual floodwater damages in the Basin total $5,334,000.[15/] Approximately 60 percent of this damage is found in the Chehalis and South Coastal subbasins. The figure below gives a breakdown of dollar damages by percentages for three major types of land use.

Average Annual Floodwater Damage, in Percentages, Southwestern Washington Study Area. (dollars)



15/ Total developed from USDA damage reports.

Floodwater Damage Reduction Needs

Lands that have a floodwater hazard need some type of treatment or measures to reduce potential damages. The type of treatment needed varies according to present land use, projected land use, intensity of flood hazard, and popularity of programs for floodwater damage reduction under consideration.

About 93 percent of lands with some flood hazard potential are not yet intensively developed, and therefore flooding does not presently result in serious financial losses. About 59,000 acres, consisting of urban developments, roads, railroads, airports, rural nonfarm residences (73 percent); and cropland in row crops, close-growing crops, vineyards, and orchards (27 percent) do incur substantial damages when rivers and streams reach flood stages. An additional 245,000 acres, mostly in hay and pasture, suffer directly or receive indirect damage through impaired use when rivers and streams overflow.[16/] Through legislation, institutional arrangements, and the employment of nonstructural measures, there is a need to equitably restrict the use of hazardous flood plain lands for intensive developments.

Additional Studies Needed

There is a need for a study to determine the exact location of undeveloped lands within floodwater hazard areas in each subbasin. These studies are essential for determining what areas should be zoned to limit future intensive land developments because of flooding hazards.

Flood plain information and flood hazard studies are also useful along those rivers and streams where urban buildup is presently heavy, or is anticipated in the near future. These studies delineate the flood plain for different frequencies of floods, and form a basis for the Department of Housing and Urban Development's flood insurance program.

16/ From SCS support data to "Washington Soil and Water Conservation Needs Inventory," April 1970.

DRAINAGE PROBLEMS

Many acres of land capability Class II through IV have a wetness problem. Aprpoximately 458,200 acres of such lands are suited for cropland (Table 56). Excess water is the dominant limitation in their use. When all land capability classes are considered, there are nearly 752,000 acres of land within Southwestern Washington that have a wetness problem.

Table 56. Inventory of Soils Having Excess Water by Land Capability Class and Subclass (w) for Subbasins, Southwestern Washington.

Subbasin	Class			
	IIw	IIIw	IVw	Vw-VIIw
	Acres			
Olympic	20,153	28,832	8,048	113,491
Chehalis	67,219	57,372	51,471	108,880
South Coastal	28,259	15,385	23,116	30,044
Cowlitz	25,744	32,448	36,172	21,755
Lewis	31,533	19,785	12,634	19,453
Total	172,908	153,822	131,441	293,623

Soil Drainage Classes

Natural soil profile drainage characteristics influence the ability of soils to retain and transmit water. Seven drainage classes have been established to group soils with comparable qualities. They are briefly described as follows:

Very Poor - Water is removed from the soil so slowly that the water table remains at or on the surface most of the time. Soils of this drainage class usually occupy level or depressed sites, and are frequently ponded. These soils are wet enough to prevent the growth of important crops, except cranberries, without artificial drainage.

Poor - Water is removed so slowly that the soil remains wet a large part of the time. The water table is commonly at or near the surface during a considerable

part of the year. Poorly-drained conditions are the result of a high water table, a slowly permeable layer within the profile, seepage, or some combination of these conditions. The large quantities of water that remain in or on the poorly drained soils prohibit growing field crops under natural conditions during most years. Artificial drainage is generally necessary for crop production, provided other soil characteristics are favorable.

Somewhat Poor - Water is removed from the soil slowly enough to keep it wet for significant periods, but not all of the time. Somewhat poorly drained soils commonly have a slowly permeable layer within the profile, a high water table, additions through seepage, or a combination of these conditions. The growth of crops is restricted to a marked degree, unless artificial drainage is provided.

Moderately Good - Water is removed from the soil somewhat slowly, so that the profile is wet for a small but significant part of the time. Soils with moderately good drainage commonly have a slowly permeable layer within or immediately beneath the solum, a relatively high water table, additions of water through seepage, or some combination of these conditions.

Good - Water is removed from the soil readily, but not rapidly. Soils with good drainage are well drained and are commonly intermediate in texture, although soils of other textural classes may also have good drainage. These soils commonly retain optimum amounts of moisture for plant growth following rains or additions of irrigation water.

Somewhat Excessive - Water is removed from the soil rapidly. Many of the soils have little horizon differentiations and are sandy and very porous. Only a narrow range of crops can be grown on these soils, and, without irrigation, the yields are usually low.

Excessive - Water is removed from the soil very rapidly. Excessively drained soils may be steep, very porous, or both. Shallow soils on slopes may be excessively drained. Enough precipitation is commonly lost from these soils to make them unsuitable for ordinary crop production.

Extent of Drainage Problems

Drainage classes by land use for Southwestern Washington are shown in Table 57. About 177,000 acres presently in agriculture and 44,000 acres of rural nonfarm and urban built-up lands have soils with very poor, poor, somewhat poor, or only moderately good drainage characteristics. Lands with these drainage characteristics and in these uses which have not been drained constitute the most urgent drainage problems of the Basin.

Need for larger drainage channels to dispose of excess water during rainy seasons is demonstrated by this scene of cranberry land near Grayland in Grays Harbor County.

Table 57. Soil Drainage Classes by Land Use, Southwestern Washington.

Class	Forest	Land in Agri-culture	Rural Nonfarm	Built-up	Barren, Other	Total
			Acres			
Very poor	71,388	30,176	1,477	6,290	45,840	155,171
Poor	94,673	56,522	2,444	8,685	4,442	166,766
Somewhat poor	104,877	23,129	2,091	6,576	1,625	138,298
Moderately Good	499,685	67,179	7,518	9,209	1,777	585,368
Subtotal	770,623	177,006	13,530	30,760	53,682	1,045,603
Percent Total	12.3	39.1	36.1	28.8	28.9	14.8
Good	5,179,352	215,959	18,510	44,562	117,609	5,575,992
Percent Total	83.1	47.6	49.2	41.8	63.3	79.5
Somewhat Excessive	244,647	32,438	2,596	18,695	2,800	301,176
Excessive	42,467	27,634	2,936	12,654	11,703	97,394
Subtotal	287,114	60,072	5,532	31,349	14,503	398,570
Percent Total	4.6	13.3	14.7	29.4	7.8	5.7
TOTAL	6,237,089	453,037	37,572	106,671	185,796	7,020,165

Source: River Basin Planning Staff.

Soil Conservation Service records indicate that during past years drainage measures installed by landowners have benefited about 120,000 acres of agricultural lands in the Basin. Some of these measures have been installed to facilitate timely removal of excess surface water resulting from overflow of streams and rivers on lands with impaired surface drainage, as well as to provide subsurface drainage relief. Some of these lands need further relief measures.

An inventory of water and related land resource problems and needs as part of the Columbia-North Pacific Region Framework Study revealed that 257,000 acres were in need of drainage relief. This estimate included some lands on which drainage measures had been installed, as well as lands needing measures to correct impaired surface drainage. Some forest lands with drainage problems were also included in this estimate.

Drainage Potentials

About 150,000 acres of land capability class-Subclass IIw and IIIw in nonagricultural use represents a high potential for future drainage if economic justification and need for expansion of agriculture occurs. Most of this land is presently in forest land use (Table 4).

IRRIGATION POTENTIAL AND NEEDS

Irrigation during dry summer periods is important to the quality of many vegetable and fruit crops in Southwestern Washington. In order to bring land under irrigation, soil, topography, and drainage conditions must be favorable for additional water application. Also, lands need to be located where a water supply is, or can be made, available at costs presently conducive to private or public development. Water rights and other institutional limitations are also factors.

The Southwestern Washington irrigation season extends from about June through September. The highest temperatures occur in July and August, with daily means from 60-67° F. Precipitation, which totals about 4-10 inches during this irrigation period, often is insufficient to maintain plant growth for an economical level of production. Periods with insufficient rainfall may continue for as long as a month or six weeks.

Sites having coarser and more shallow soils are benefited by irrigation more than sites with moderately fine textured and deeper soils. Lighter applications of water and shorter intervals between irrigations are common to coarser and shallower soils.

Irrigation Limitation Classes

In Southwestern Washington, lands have been placed into four classes of limitations for irrigated farming. These four classes, based upon physical suitability for irrigation exclusive of climate, economic factors, and water supply, are listed below.

Slight - Soils are suited to all climatically adapted crops, including truck and row crops, small grains, grasses and legumes. Generally, row crops can be grown up to about half of the time. Soils are permeable and dominantly deep and medium textured. A few are moderately coarse and moderately fine textured. Soils hold more than 7.5 inches of available water. The water table is below the major rooting zone during the growing season, and floodwater is not a hazard. Slopes are from 0-8 percent.

Moderate - Soils are suited to close-growing grain crops, grasses, and legumes, but, unless very careful management is applied, are not generally suited to row crops because of slope or coarse texture. Soils have slow to rapid permeability and may be moderately deep with a range from coarse to fine textures. A few soils are gravelly or cobbly. Soils hold more than 5 inches of available water. It is practical

to lower the water table by drains below the major rooting zone during the growing season. Generally, floodwater is not a hazard during the growing season. Slopes are mostly from 8-15 percent.

Severe - Soils are suited to grasses and legumes, and to some extent, to close-growing grain crops. Soils have very slow to very rapid permeability and may have shallow depths. Soil textures range from coarse to fine and some soils are very gravelly or very cobbly. Soil holds more than 2 inches of available water. The water table can be maintained below 18 inches most of the growing season. Floodwater may overflow two or three times during a 10-year period. Most slopes are 15-30 percent.

Very Severe - Soils generally not suited for irrigation development because of steep slopes, very shallow depths, rockiness, stoniness, or coarse textures. Some soils are extremely gravelly or extremely cobbly. Soils hold less than 2 inches of available water. The water table may be above 18 inches most of the growing season, and floodwater may overflow more than three times during a 10-year period. Where slopes alone constitute very severe limitations, the slopes are over 30 percent.

Irrigation limitation classes are shown in Table 58.

Table 58. Irrigation Limitation Classes for Southwestern Washington, by Subbasins.

Class	Olympic	Chehalis	South Coastal	Cowlitz	Lewis
	----------Acres----------				
Slight	30,185	56,685	23,705	41,344	73,671
Moderate	106,020	303,869	90,675	155,928	173,564
Severe	229,463	565,607	137,826	345,481	282,350
Very Severe	1,375,966	768,790	639,022	1,031,114	588,905
Total	1,741,634	1,694,951	891,228	1,573,867	1,118,490

Irrigation Potentials

Table 59 displays irrigation limitations in relation to five broad land use categories. Expansion of irrigation does not seem to be seriously limited by potential of available land resources. If non-irrigated lands in agriculture (cropland and pasture) were considered exclusively, nearly 64 percent have only slight or moderate limitations for irrigation. Development of irrigation on these lands would increase the acreage of irrigation nearly tenfold. The largest category of land use having slight or moderate limitations for irrigation is forest.

The Soil Conservation Service has estimated irrigation expansion possibilities from the standpoint of land resources, and readily available and dependable water supplies. 18/ Eliminating from consideration lands which could be irrigated by means of complex water storage and distribution systems, it is judged that about 200,000 acres could be developed for irrigation primarily through the efforts of individual landowners or through small group projects. A large share of this increase would logically come from lands already in agriculture.

Washington State University, in a study coordinated by the State of Washington Water Resource Center, has concluded that about 600,000 acres have potential for irrigation insofar as land and water resources are concerned. 19/ Expansion of irrigation to this extent would involve complex systems for water storage and distribution, and would represent more nearly an absolute long-term potential for increasing irrigation.

Irrigation Needs

An inventory of 125 small watersheds comprising Southwestern Washington provides an acreage estimate of irrigation needs. 20/ About 140,000 acres, including most lands presently irrigated, were judged to need irrigation to optimize production of crops presently being grown. If all lands now irrigated meet this criteria, expansion of irrigation by about 110,000 acres is needed. Satisfying this need would increase the percentage of agricultural lands irrigated from less than 7 percent to about 30 percent. In addition to the expansion of irrigated acreage, modernization of existing facilities and improved management of irrigation water constitute further needs affecting agricultural lands under irrigation.

18/ SCS data supporting Columbia-North Pacific Type I River Basin study, 1967.

19/ Volume III of Report #2, "An Initial Study of the Water Resources of the State of Washington," February 1967.

20/ SCS data supporting "Washington Soil and Water Conservation Needs Inventory," April 1970.

Table 59. Irrigation Limitation Classes by Land Use, Southwestern Washington.

Limitation Class	Forest	Land in Agriculture	Rural Nonfarm	Built-up	Barren, Other	Total
Slight	118,848	82,887	6,699	16,514	642	225,590
Moderate	575,074	206,075	14,218	31,367	3,322	830,056
Subtotal	693,922	288,962	20,917	47,881	3,964	1,055,646
Percent	11.1	63.7	55.7	44.9	2.1	15.0
Severe	1,368,771	129,865	12,560	39,376	10,155	1,560,727
Very Severe	4,174,394	34,212	4,095	19,414	171,682	4,403,797
Subtotal	5,543,165	164,077	16,655	58,790	181,837	5,964,524
Percent	88.9	36.3	44.3	55.1	97.9	85.0
Total	6,237,087	453,039	37,572	106,671	185,801	7,020,170

Source: River Basin Planning Staff.

MUNICIPAL, INDUSTRIAL, AND RURAL WATER SUPPLY NEEDS 21/

Adequate water resources exist in Southwestern Washington to meet all foreseeable requirements for municipal, industrial and rural water supplies through the year 2020. In fact, surface water supplies alone are more than adequate to meet projected requirements in most subbasins.

The basic problem is that available water supplies are not evenly distributed with demands. Certain areas have an abundance of surface and ground water, but have few people or industries to make use of supplies. Other areas have people and industries, but lack water to supply their wants and needs. Other areas may have the people and the water, but lack adequate distribution and storage facilities. Other areas may have the people, water, and distribution facilities, and still may not be able to make use of them because of poor water quality. 22/

During an inventory of small watersheds as part of a conservation needs inventory for the State it was determined that about 40 percent of the small watersheds in Southwestern Washington had some problems associated with rural and municipal-industrial water supply. 23/

The majority of areas with insufficient water can be found along the Pacific Coast. Here, ground water withdrawal is limited by salt water intrusion. Rivers and streams are also affected by salt water several miles from their mouths. Other areas not presently needing additional water will need this water in the very near future. This includes most larger cities, and many smaller towns and villages. The Columbia-Pacific Resource Conservation and Development Project, covering Grays Harbor, Pacific and Wahkiakum Counties is currently sponsoring a U.S. Geological Survey water supply study on Long Beach Peninsula.

Presently, many smaller towns, villages, rural areas, and the city of Chehalis are having problems with their old distribution systems or have no distribution system at all. As the larger cities and towns add additional water supplies, their distribution and storage facilities will be inadequate.

21/ Most information in this section, for the Basin and each subbasin, is from "Municipal, Industrial and Rural Water Supply in Southwest Washington," prepared by the Washington State Department of Social and Health Services for the Department of Ecology.

22/ This section is limited to adequacy or inadequacy of water supply and distribution systems. Water quality is discussed under "Water Quality."

23/ SCS data supporting "Washington Soil and Water Conservation Needs Inventory," April 1970.

Water Supply Needs – Future water requirements for Southwestern Washington will be determined by rate of growth, population, industry, and agriculture, and by the efficiency with which the available water is used. The 1970 population of 346,700 is projected to increase to 509,900 by 2020. This represents a 47 percent growth during the projection period. Based on these population projections, municipal water use is expected to increase from an average use of 41 million gallons a day (mgd) in 1970 to 72 mgd in 2020, an increase of nearly 76 percent.

Industrial use is dominated by the pulp and paper industry, which accounts for nearly 90 percent of total water use by industries. Industrial water use is expected to increase from an average of 474 mgd in 1970 to 1,049 mgd by 2020, an increase of 121 percent.

Rural-individual and small rural community systems have been predominantly served by wells. This trend is expected to intensify, and by 1980, almost 100 percent of these systems will be from ground water sources. Rural use is expected to increase from an average of 5.4 mgd in 1970 to 14.6 mgd by 2020, an increase of 170 percent.

Per capita consumption of water is also expected to rise. The average use per person per day is expected to go from 142 gallons in 1970 to 178 gallons by 2020 for larger water systems. Rural community and rural individual use is expected to increase from 60 gallons per person per day to 100 gallons per person per day over the same time period.

Table 60 gives future needs for domestic and minor industrial water supply by subbasins for Southwestern Washington. Needs are in million gallons per day and are separated by time frames.

Table 60. Future Domestic and Minor Industrial Water Supply Needs, Southwestern Washington. [a/]

Subbasin	1980	2000	2020
	-------Million gallons daily------		
Olympic	1.35	1.60	2.09
Chehalis	11.31	16.39	21.66
South Coastal	7.09	9.52	12.35
Cowlitz	4.54	6.22	8.14
Lewis	19.39	27.69	34.73
Total	43.68	61.42	78.97

a/ Data taken from Municipal, Industrial and Rural Water Supply in Southwestern Washington, Department of Ecology, State of Washington.

Studies to determine adequacy of ground water supplies are needed in both South Coastal and Lewis subbasins. The extent of water supply problems in new housing developments and in rural areas is not completely known for all subbasins. A study is needed to pinpoint problems in these areas.

WATER QUALITY PROBLEMS

Extent of water quality problems is reflected by a survey of small watersheds conducted as part of the conservation needs inventory of the State. During this survey, it was revealed that two-thirds of the small watersheds in Southwestern Washington had some kind of problem affecting water quality. 24/

Local and state agencies have conducted numerous special studies on water quality and quantity for Southwestern Washington. Detailed studies of Willapa Bay and Long Beach have been completed. The State of Washington has studied water quality, by subbasins, throughout the basin. Interstate groups, such as CRAG, have investigated water needs and distribution systems for the Portland, Oregon, and Vancouver, Washington, area. These studies should be reviewed whenever a specific community or locality is concerned about the quality of surface and ground water.

Septic Tank Absorption Problems

A major water quality problem in Southwestern Washington is concerned with rural-farm and rural-nonfarm water quality problems due to contamination of ground water supplies from septic tanks. Soils in Southwestern Washington are classified into groups which indicate limitations for septic tank absorption fields. The criteria for rating soils (slight, moderate, severe, and very severe) for use as absorption fields is based on limitations of soils to absorb effluent, soil depth, land slope, flooding hazard, and other less important factors.

Septic tank limitations, by subbasins, are shown in Table 61. Nearly 56 percent of the acreage in the Basin falls into the "severe" classificiation. Nearly one-third of this classification is located in the Chehalis subbasin.

Sanitary Landfill Problems

A potential source of pollution of surface and ground water supplies concerns soils on which sanitary landfills are located. Soils in the Basin have been classified for use as sanitary landfill areas. Sanitary landfill areas are for underground burial of garbage and trash. Chief requirements are deep, well drained soils, free of flooding and easy to excavate.

24/ SCS data supporting "Washington Soil and Water Conservation Needs Inventory," April 1970.

Sanitary landfill classes are intended only to aid with preliminary site selection and evaluation for sanitary landfills. The ratings are based on soil profiles to a depth of 5 feet. Geologic investigation of materials below this depth will need to be made onsite before final determination of site-limitation can be made. Table 62 gives sanitary landfill limitation classes for Southwestern Washington by subbasins.

Table 61. Septic Tank Limitations for Southwestern Washington, by Subbasins.
(in acres)

Class	Olympic	Chehalis	South Coastal	Cowlitz	Lewis	Total
Slight	21,797	83,566	---	11,743	31,825	148,931
Moderate	13,739	29,942	18,361	112,435	91,517	266,264
Severe	970,269	1,253,270	406,774	634,214	623,838	3,888,365
Very Severe	210,642	111,504	---	497,321	272,834	1,092,301
Unclassified	525,187	216,669	465,823	318,154	98,476	1,624,309
Total	1,741,634	1,694,951	891,228	1,573,867	1,118,490	7,020,170

Source: River Basin Planning Staff.

Table 62. Sanitary Landfill Limitation Classes for Southwestern Washington, by Subbasins.

(in acres)

Class	Olympic	Chehalis	South Coastal	Cowlitz	Lewis	Total
Slight	3,938	2,452	2,001	13,685	38,322	60,398
Moderate	53,374	197,093	33,843	118,720	98,322	501,352
Severe	954,816	1,282,704	389,938	634,705	631,905	3,894,068
Very Severe	204,539	---	---	488,603	251,464	944,606
Unclassified	524,967	212,702	465,446	318,154	98,477	1,619,746
Total	1,741,634	1,694,951	891,228	1,573,867	1,118,490	7,020,170

Source: River Basin Planning Staff.

The three sanitary landfill area limitation classes are briefly described as follows:

Slight: Generally includes nonstony or stony sandy loam to silt loam soils that are well to excessively drained. Soils are very deep to hard rock or water table, occupy nearly level and gently slopes, and have no flood hazard.

Moderate: Generally includes soils that are very deep to hard rock or water table and have no flood hazard. Soils may have one or more of the following factors: (1) moderately good or excessive drainage, (2) moderate slopes, (3) sandy clay loam to silty clay loam or loamy sand and sand textures that may be very stony.

Severe: Generally includes soils with one or more of the following factors: (1) depth less than 5 feet to hard rock or water table, (2) somewhat poor to very poor drainage, (3) moderately steep or steeper slopes, (4) sandy clay to clay textures that may be extremely stony, and (5) flood hazard.

The majority of acreage described by sanitary landfill limitation classes for Southwestern Washington falls into the "severe" classification. The Chehalis subbasin contains approximately one-third of this classification. There are only 60,398 acres within the Basin that are classified as "slight".

In general, overall quality of surface and ground water within Southwestern Washington is good. There are, however, significant variations by subbasin and watershed. To maintain overall water quality standards, septic tank locations and sanitary landfill sites must be carefully considered.

LAND USE PROBLEMS

Almost 95 percent of the land in Southwestern Washington is covered by forest or used for agriculture; 88 percent is in forest. Urban, industrial and rural nonfarm residential use of land which encroaches on highly productive agricultural land as well as forest land constitutes a land use problem of the Basin. The effect of urban expansion often extends beyond areas immediately involved by inducing management problems, increases in assessed valuation, and taxation on adjacent properties.

Problems associated with urban development of flood plain lands also exist. Encroachment by new developments not only extend the problem but usually increase future flood damages to existing facilities. Development of land use policies and institutional arrangements which reduce present and future costs of flood control and protection are needed.

Lands once in agriculture and forest and now being developed for residences, is frequently unsuitable for such uses, primarily because of septic tank limitations. In areas such as eastern Clark County, this problem is severe and needs immediate attention.

Changing land use is of concern in relation to forest land, since demand for forest products is increasing. There is also a problem with forest land that has been harvested but not replanted. This land needs to be reforested to bring it back to a productive state and to control erosion.

Agriculture

A problem facing agricultural expansion in Southwestern Washington is competition for use of lands. Increased utilization of cropland and pasture for rural nonfarm residences and suburban homes is becoming increasingly common, especially in the southern portions of the Basin. The total acres of cropland, as well as the total number of farms, have been decreasing since 1949. The effects of private residential construction and rural nonfarm development have accelerated shifts of land use from agricultural to nonagricultural, and as a result may restrict the production of forage crops. The present distribution of crops on lands in agriculture is displayed in Table 63.

Table 63. Summary of Agricultural Land Use by Subbasin, Southwestern Washington, 1969.

Land Use	Subbasin				
	Olympic	Chehalis	Coastal	Cowlitz	Lewis
	Acres				
Field Crops	---	5,323	603	---	623
Brush Fruits	---	548	1,628	160	1,355
Other row crops	---	3,907	566	220	10,364
Hay-rotation pasture	6,704	123,345	40,277	63,939	116,491
Brush pasture	421	16,147	4,383	18,436	994
Native pasture	1,984	14,911	7,102	5,839	6,769
Total	9,109	164,181	54,559	88,594	136,596

Source: River Basin Planning Staff.

Much of the agricultural land, as shown in Table 63 above, is utilized in the production of hay and pasture. Large areas of cropland in Chehalis and Lewis subbasins are used for production of seeded hay and pasture. Drainage and irrigation (discussed earlier) are water management problems associated with the lands in agricultural use. Improved management of pastures, including seeding of improved varieties, is needed on land which is producing forage. Such lands account for about 95 percent of lands in agricultural use.

Land use pressures and new technologies have induced pollution problems in some areas of Southwestern Washington. Higher concentrations of livestock and pollution from pesticides and fertilizers cause significant problems within certain geographical areas. The dairy industry is presently faced with a major waste disposal problem.

A problem with noxious weeds exists throughout the Basin. One of these weeds which is spreading is tansy-ragwort. This weed is poisonous to livestock.

RECREATION PROBLEMS

Southwestern Washington has an abundance, and a wide variety, of recreational opportunities available. From ocean beaches to clean, clear streams, to high mountain wilderness, opportunities abound. Figures 7 and 8 show the natural and developed recreation sites within the Basin.

One of the major recreational needs within the Basin is for more developed sites on freshwater shoreland. Several large reservoirs in the area have facilities for swimming, boating, picnicking, and fishing. There are also some proposed reservoirs which could have recreational development constructed on them. Development of these sites, as well as additional sites, on existing reservoirs and rivers would add a valuable resource to the area. Suitability of such sites from the standpoint of soil and land resources would influence final development decisions.

Another need is for additional overnight facilities for visitors. Southwestern Washington is becoming increasingly popular as a vacation spot. Use of the area will more than triple by 2020, to almost 80 million visitor-days. Table 64 shows the projected use of the area, as well as land and water requirements for this use. Development of additional overnight facilities will be necessary in order to meet requirements of these visitors. Suitability of sites will depend on a study of soils and their fitness for needed facilities.

Table 64. Projected Total Use, Water Related Use, and Land and Water Requirements for Recreation in Southwestern Washington.

	1980[a/]	2000[a/]	2020[a/]
Total Use (1,000 (visitor-days)	23,740	43,350	79,900
Water Related Use (1,000 visitor-days)	8,460	16,200	29,700
Surface Water Requirements (acres)	36,230	69,120	127,840
Land Requirements (acres)	4,440	8,270	15,250
Federal Land Requirements (acres)	900	1,550	2,860
State Land Requirements (acres)	2,060	3,930	7,290
County & Municipal Land Requirements (acres)	820	1,490	2,670
Private Land Requirements (acres)	660	1,310	2,420

a/ From Appendix XIII of the Columbia-North Pacific Region Comprehensive Framework Study of Water and Related Lands.

Table 65 shows federal land requirements, national forest land requirements, and national forest development needs for the same period. Current overnight developments on national forests are sufficient to meet needs in all subbasins until 2000, and in Olympic, Chehalis and South Coastal subbasins until 2020. The main development needs are in Cowlitz and Lewis subbasins, where an additional 126 acres of sites need to be developed by 2020.

Table 65. Federal Land Requirements, National Forest Land Requirements and Development Needs for Water Related Recreation in Southwestern Washington. [a/]

	Existing	1980	2000	2020
	----------Acres----------			
Federal Land Requirements				
Olympic, Chehalis, South Coastal		400	750	1360
Lewis, Cowlitz		500	800	1500
National Forest Land Requirements				
Olympic, Chehalis, South Coastal	133	10	30	50
Lewis, Cowlitz	424	180	290	550
National Forest Development Needs				
Olympic, Chehalis, South Coastal		0	0	0
Lewis, Cowlitz		0	0	126

a/ From Appendix XIII Columbia-North Pacific Comprehensive Framework Study of Water and Related Lands.

FISH AND WILDLIFE PROBLEMS

Southwestern Washington has an abundance of fish and wildlife species. Problems associated with these species center around man's encroachment on their habitat.

Fish – Limiting factors for fish production in Southwestern Washington include natural and man-caused conditions. Natural conditions are physical barriers such as waterfalls and natural debris jams, extensive high or low flows, and lack of suitable spawning and rearing areas.

Wildlife – The primary limiting factor for big game in Southwestern Washington is the availability of high quality food. The critical season for deer and elk is during winter when browse is in short supply or is covered by snow. For bear, the critical season is in early spring after hibernation and when forbs and berries are not yet available. Man's efforts to control wildfire and preservation of large areas in national parks have reduced openings due to fire or logging activities, thus reducing the amount of land available for invading browse species.

Primary habitat for most furbearers is threatened by agricultural and urban development, which often leads to draining of marshes and shallow water areas. Dredging and straightening of streams also reduces prime habitat.

Habitat for migrating waterfowl is adversely affected by pollution, which kills mollusks and other marine life upon which waterfowl feed. Water developments inundate nesting and feeding areas, but they do provide resting areas. Changing agricultural crops from grain to livestock has reduced the food supply, and thus the carrying capacity.

EXISTING WATER AND RELATED LAND RESOURCE PROGRAMS and PROJECTS

EXISTING WATER AND RELATED LAND RESOURCE PROGRAMS AND PROJECTS

A variety of programs provide technical services and funding leading to projects which develop and protect water and related land resources. These programs are administered by various state and federal agencies. Discussion of the significant resource programs follows.

UNITED STATES DEPARTMENT OF AGRICULTURE PROGRAMS

Soil Conservation Service

The Soil Conservation Service (SCS) provides advice and recommendations on policies for soil and water conservation and related practices under the Rural Environmental Conservation Program (RECP) of USDA, including conservation planning requirements for long-term contracts. SCS also provides technical assistance to program participants in the installation of soil and water conservation, pollution abatement, wildlife and recreation practices approved for cost-sharing assistance, and certifies that landowners have obtained approval of Soil and Water Conservation Districts for conservation plans, where necessary. SCS provides County Agricultural Stabilization Committees of USDA with priority ratings of applicants, based upon criteria and guidelines approved by the Secretary in developing multiyear contracts for approval by County ASC Committees.

The SCS provides technical assistance for more difficult practices called for in conservation plans, such as layouts, design and supervision of construction of farm ponds, terrace systems, diversions, and waterways. Guidance is provided for maintaining the measures and practices after they have been applied.

SCS provides soil maps and interpretations to local officials and planning boards, to developers and engineers, and to others engaged in state, regional, and community planning. Use of this information results in savings of time and money, and more accurate estimates of construction costs. It influences land use compatibility with soil conditions, landscape, and flood hazards, and leads to improved designs of highways, parks, and housing developments.

P.L. 83-566 Small Watershed Projects — The Watershed Protection and Flood Prevention Act (Public Law 83-566) authorizes the Secretary of Agriculture to give technical and financial help to local organizations in planning and carrying out small watershed projects. These projects can be for flood prevention, agricultural water management, recreation, fish and wildlife development, and municipal and industrial water supply. The program is administered by the Soil Conservation Service (SCS) with assistance provided by other USDA agencies as appropriate. The project's purposes are usually accomplished through a combination of land treatment, structural, and nonstructural measures. The projects are locally initiated,

built with the help of SCS, and become local projects once they are constructed. Eligible watersheds are limited to 250,000 acres, and a reservoir constructed under the authority cannot hold more than 25,000 acre-feet of water for all purposes.

There are two completed small watershed projects under P.L. 83-566 authority in Southwestern Washington--Silver Lake (23-20) in Cowlitz subbasin, and Lacamas Creek (0-58) in Lewis subbasin. Eleven applications for additional projects have been filed, but none are being actively furthered by local sponsors at present.

Resource Conservation and Development Projects – The SCS, with other USDA agencies as appropriate, is authorized to provide technical and financial assistance to local groups in conserving and developing their natural resources. These rural-urban projects are locally initiated, sponsored and directed; and provide local groups with the opportunity to coordinate and use federal, state, and local facilities to develop the natural resources for economic improvement and community betterment.

Purposes for which assistance is available to eligible sponsors include: treatment of critical erosion areas, flood prevention, farm irrigation, land drainage, soil and water management for agriculture-related pollutant control, public water-based fish and wildlife and recreation development (structures and land rights), water quality management and accelerated services, such as soil surveys or similar studies. Assistance is also provided for planning forestry measures, accelerated forest fire protection, and woodland related practices.

The Columbia-Pacific RC&D project, located in Grays Harbor, Pacific and Wahkiakum Counties, was granted planning authorization in February 1971. Authorization for operations was announced in November 1972. This authorization provides USDA funds for technical and financial assistance to local units of government. City, county and state properties within project boundaries are eligible for RC&D technical help, grants, or loans for project measures. Also eligible are special-purpose districts and public nonprofit corporations having authority and ability to install, operate and maintain community-type measures.

Thirteen project measures had been completed in the Co-Pac RC&D as of the end of 1973. More measures are planned, or are in process as of July 1, 1974.

Extension Service

The Extension Service is part of the Cooperative Extension Service partnership. Federal, state, and county levels of government share in financing, planning, and carrying out information and educational programs. The Extension Service acts as the educational agency of the

U.S. Department of Agriculture and land grant universities. Extension specialists and county agents work with other agencies to provide local people with information relating to soil and water conservation programs plus other types of information and assistance. This work has been an integral part of USDA since 1914, when the Smith-Lever Act became law.

Agricultural Stabilization & Conservation Service

The Agricultural Stabilization and Conservation Service (ASCS), through their Rural Environmental Conservation Program, provides cost-sharing to landowners and operators for carrying out selected conservation practices on agricultural land. This includes practices contributing to conservation and development of soil, water, plant, wildlife, and other resources, as well as those effective in reducing or controlling erosion, and resulting sedimentation, and chemical and animal-waste pollutants. The cost-sharing program is available to individual farmers and ranchers, as well as to groups of landowners who have common problems too large or complex to be handled individually. The program also provides cost-sharing for installing emergency conservation practices needed as a result of a natural disaster. The Soil Conservation Service is responsible for technical phases of the program.

The Agricultural Stabilization and Conservation Service administers the USDA Agriculture Farm Program, relating to agriculture production control. It also administers the Agriculture Commodity Storage and Loan Program.

ASCS administers long-term cost-share agreements and contracts, utilizing State and County Committees established under Section 8(b) of the Soil Conservation and Domestic Allotment Act, as amended.

Forest Service

Cooperative state and private forestry programs are varied and cover virtually all major fields of forest management and protection. Cooperative programs include fire protection; technical assistance services; forest pest, insect, and disease control; tree seeding and planting; tree seedling production; forest management; forest watershed management; forest products harvesting; processing and marketing; and forest research.

The major cooperative programs are:

(1) Section 4 of the Clark-McNary Act of 1924 gives the U.S. Forest Service authority to cooperate with the states in growing, and distributing to landowners tree seeds and planting stock. This program is not operative at this time in Washington. It has been used in the past, and is available if the need arises.

(2) The Agriculture Act of 1956, Title IV, charges the Forest Service to assist the states in bringing into production commercial forest land not adequately stocked with marketable tree species.

(3) The Cooperative Forest Management Act of 1950, amended 1962, provides for programs designed to enable state foresters to give assistance to private forest owners, especially owners of small woodlands. It also provides for assistance to loggers and processors of primary forest products.

(4) Section 2 of the Clark-McNary Act of 1924 provides authority for cooperative fire control. Under this act, states and the federal government have joined to provide for, or make available, adequate fire control on nonfederal lands. The federal government can match state and private expenditures up to 50 percent.

The Forest Service provides advice and recommendations on policies for all aspects of forestry practices under the RECP, including assistance to applicants for forestry incentives as specified in Section 1003 of the Agriculture and Consumer Protection Act of 1973.

For the Forestry Incentives Program, as specified in Section 1009 of the Act, the Forest Service, in consultation with State Foresters, develops recommendations for allocating funds to states and counties, for technically sound forestry practices eligible for cost-sharing, for establishing priority of applicants for cost-share assistance, and for methods to encourage utilization of private agencies, firms, and individuals furnishing services and materials needed for timber incentive practices.

The Forest Service is responsible for administering technical assistance, through State Foresters, in the planning and installation of forestry incentives practices approved for cost-sharing. The Forest Service is helping to fund a Utilization and Marketing Forester for the Columbia-Pacific RC&D project. Forest Service employees are continually working with state and local officials to improve forest management.

Under auspices of the Intergovernmental Personnel Exchange Act, the Forest Service, in 1973 and 1974, provided a forester to Grays Harbor and Pacific Counties' Regional Planning staffs. A similar ongoing program enables the State Department of Natural Resources to provide a forester to the State Office of Community Development. The purpose of these programs is to contribute forestry expertise to the planning process at the local level.

Under the cooperative program, the Forest Service also provides money to the State Department of Natural Resources (DNR) to help fund the farm forestry program. Assistance is available to help small landowners manage their stands of timber, and to instruct them in proper methods of sale, layout, and road design, to minimize erosion. Information about this program can be obtained from DNR.

The Forest Service is actively engaged in the protection and development of natural resources on publicly-owned lands. It manages approximately 1.3 million acres of national forest land in Southwestern Washington for multiple use and sustained yield of all renewable natural resources, including wood, water, wildlife, forage and recreation. Purposes for management of resources are to provide a sustained-yield flow of timber from the commercial forest areas of the National Forest System consistent with maintenance of environmental and quality harvesting standards; to maintain and improve a continuous flow of high quality water and conserve the soil; to maintain and improve the habitat for all species of furred, feathered, and finned wildlife on national forest lands; to provide forage to meet increasing demands of domestic livestock and big game populations; and to provide a wide variety of recreational opportunities for forest visitors.

Farmers Home Administration

The Farmers Home Administration (FmHA) makes water development and soil conservation loans to eligible individual farmers, rural residents, groups of farmers and rural communities. These loans are for the purpose of developing water supply systems for domestic, livestock, and irrigation use; and for carrying out soil conservation practices. Each loan is scheduled for repayment in accordance with the borrower's ability to repay over a period not to exceed 40 years. In addition to loans to individuals and groups, loans are also made to local organizations to help finance projects and develop land and water resources in watersheds planned under authority of Public Law 83-566. Eligible local organizations include flood control districts, irrigation districts, drainage districts, and similar legal entities which have authority under state law to construct, maintain, and operate works of improvement. These watershed loans are repayable over periods up to 50 years.

The major purposes of FmHA's rural credit programs are:

1. To help build the family farm system, the economic and social base of many rural communities.

2. To expand business and industry, increase income and employment, and control or abate pollution.

3. To install water and waste disposal systems and other community facilities that will help rural areas upgrade the quality of living and promote economic development and growth.

4. To provide or improve modest homes in suitable rural environments at prices and on terms that families of low or moderate incomes can afford.

Economic Research Service

The Economic Research Service conducts national and regional programs of research, planning, and technical consultation, and services pertaining to economic and institutional factors and policy which relate use, conservation, development, management, and control of natural resources. This includes determining their extent, geographic distribution, productivity, quality, and contribution of natural resources to regional and national economic activity and growth. Also included are: resource requirements, development potentials, and resource investment economics; impact of technological and economic change on the utilization of natural resources; resource income distribution and valuation; and recreational use of resources. The agency also participates in departmental and interagency efforts to formulate policies, plans, and programs for the use, preservation, and development of natural resources.

Agricultural Research Service

The Agricultural Research Service conducts research aimed at finding better ways of storing, saving, transporting, and using water. It continually conducts research, both on physical requirements for, and physical effects of, soil and water conservation. The research program is oriented primarily to needs of farmers and conservationists for scientific determination of effectiveness and feasibility of conservation practices. A few examples of many studies being made are: water management, including requirements and consumptive use of agricultural crops; sediment yield and delivery rates; conservation cropping systems and residue management; and hydraulic characteristics of surface methods of irrigation.

OTHER PROGRAMS

Department of Interior, U.S. Bureau of Reclamation (USBR)

USBR is responsible for studies of potential irrigation projects or projects with multipurpose benefits. Comprehensive studies have been completed on four dams and reservoir sites in Southwestern Washington. Two are situated in the Chehalis and two in the South Coastal subbasins. All would have irrigation as a primary purpose, with flood control or municipal-industrial water as secondary purposes. Economic feasibility precludes project implementation at this time.

Department of Interior, U.S. Fish and Wildlife Service (USFWS)

The Fish and Wildlife Service aids in the conservation of the Nation's migratory birds, mammals and sport fishes. This includes the application of research findings in the development and management of a system of national wildlife refuges for migratory birds and endangered species; operation of a system of fish hatcheries; management of populations of migratory game birds through regulation of time, degree and manner of harvest; biological monitoring of development projects; and enforcement of several laws, including the Endangered Species Act, the Lacey Act, the Marine Mammals Protection Act, and the Migratory Bird Treaty Act.

Department of Defense, Corps of Engineers

The Corps of Engineers has done considerable work in all subbasins, WITH the exception of the Olympic. Most of this work consisted of levees, dikes and pumping plants, on main rivers such as the Columbia, Cowlitz, Lewis, Chehalis, and Willapa. They have built one dam on the Wynoochee River. This reservoir combines flood control, recreation, and municipal and industrial water supply.

Department of Commerce, National Atmospheric and Oceanic Administration, National Marine Fisheries Service (NMFS)

NMFS promotes the protection and rational use of living marine resources for their esthetic, economic and recreational value to the American people; administers programs to determine the consequences of man's activities on living marine resources; and provides knowledge and services to foster efficient international management, use and protection of living marine resources.

Department of Ecology, State of Washington (DOE)

DOE is responsible for planning, management and regulatory functions applicable to water and related land resources of the state. Coordination of federal and state grants for planning and construction is administered by the department. Floodwater damage, shoreline management, coastal zone management, water quality and water rights are among resource management functions administered by DOE.

Department of Natural Resources, State of Washington (DNR)

DNR is responsible for the management of state-owned land. It is responsible for regulatory functions on private forest land, and also for fire and disease control on private forest land. DNR provides assistance to private landowners in application of forest practices, and to loggers and wood processors.

State Departments of Game and Fisheries

The Washington State Departments of Fisheries and Game are respectively responsible for managing food fishery resources, and sport fisheries and wildlife. Management includes habitat manipulation and improvement, and regulation of limits and methods of harvest and production of fish and wildlife to supplement natural reproduction. Several parcels of land are managed for both fish and wildlife, and providing public recreation.

The Departments of Game and Fisheries have completed inventories of the present distribution and abundance of fish and wildlife within the study area. The inventories note factors limiting production, and cite means to improve fish and wildlife populations. Projections of future needs to satisfy the recreational demand are also included.

Conservation Districts

Conservation districts are legal subdivisions of state government, organized under state law. They serve to coordinate soil and water conservation programs within their jurisdiction. In Southwestern Washington, six conservation districts lie wholly within the Basin, namely: Clark County, Cowlitz, Grays Harbor, Lewis County, Pacific, and Wahkiakum. Five others lie partly within the Basin, namely: Clallam, Jefferson County, Mason County, Thurston County, and Underwood.

Through memorandums of understanding with federal, state, and county departments and agencies, districts obtain cooperation and assistance which further mutual objectives of conservation and solutions to

water and related land resource problems. Through appropriate memorandums, the Soil Conservation Service of USDA assigns technical personnel to districts to assist private and corporate landowners to develop comprehensive soil and water conservation plans. Landowners signing cooperative agreements with conservation districts indicate an interest and intent to carry out a conservation program, and are eligible to receive planning assistance. Technical assistance is also available to district cooperators in implementation of programs and practices which mitigate erosion sedimentation, flooding, drainage, and similar water and related land resource problems.

Within conservation districts of Southwestern Washington there are 11,126 operating units comprising 3,146,400 acres of land. Operating units are defined as those units of land where the primary objective of the operation is to manage land and related natural resources to produce income from plants, animals, or related outdoor recreation or wildlife. In the case of conservation districts they represent the potential for total numbers and acreage of district cooperative agreements and comprehensive plans affecting private and corporate ownerships or public lands leased to private operators. Lands of public land managing agencies (federal and state) which conduct conservation programs of their own are not included in this potential. As of December 31, 1974, 38 percent of the operating units and 21 percent of the acreage of these units were under cooperative agreement with conservation districts. Comprehensive conservation plans cover 26 percent of the operating units and 11 percent of the acreage. This progress reflects the status of ongoing programs supported by USDA affecting private and corporate-owned lands, and indicates future needs for extending these programs in Southwestern Washington.

Utility and Water Control Districts

A number of subdivisions of state government in addition to conservation districts, have responsibilities for and interest in land and water resource planning and program activities. These districts are countywide in scope in some cases and local in others. Table 66 tabulates the kind and number of these districts in counties which are entirely or partially within Southwestern Washington, including conservation districts.

Other

National Flood Insurance Act – This act, administered by the Insurance Administration of the Department of Housing and Urban Development (HUD) is designed to mitigate flood damages incurred by property owners within flood plain areas. Insurance is available through private insurance companies only if legal entities (city or county) have authority to regulate flood plain land use, make formal application, and satisfy other program requirements.

Table 66. Number and Type of Districts in Southwestern Washington Counties with Responsibilities and Interest in Land and Water Resource Programs.

District Type[a]	COUNTIES										
	Mason[b]	Clallam[b]	Jefferson[b]	Grays Harbor	Pacific	Thurston[b]	Wahkiakum	Cowlitz	Clark	Lewis	Skamania[b]
Conservation	1	1	1	1	1	1	1	1	1	1	1
Diking	--	--	--	--	2	--	2	4	--	--	--
Flood Control	1	--	--	1	--	--	1	1	--	--	--
Irrigation	--	4	--	--	--	--	--	--	--	--	--
Drainage	--	--	3	--	2	5	--	1	5	--	--
Port	4	1	--	1	4	1	2	3	3	--	1
Public Utility	2	1	--	1	1	1	1	1	1	1	1
Sewer	--	--	--	--	1	--	--	1	1	--	--
Water	--	--	2	3	2	1	--	--	--	1	2

a/ Data taken from Directory of Public Agencies and private groups interested in the Water Resources of Washington. December 1974. WRIS Bulletin No. 17.

b/ These counties lie partially outside Southwestern Washington; hence, number of districts may exceed those in the study area.

Flood Hazard Studies – The Corps of Engineers, U.S. Geological Survey, National Weather Service, and Soil Conservation Service are organized to conduct flood plain information studies which guide communities in establishing regulations for use of flood plain lands to minimize flood damages. Coordination and establishment of priorities for these studies are through the State Department of Ecology, Office of Land Programs.

Water Supply – The Columbia-Pacific RC&D has sponsored a U.S. Geological Survey study of water supply for Long Beach peninsula.

Power Companies – The city of Tacoma Power and Light Company has completed two dams on the upper Cowlitz River which provide some downstream flood protection in addition to the primary purpose of power generation.

Lake Merwin Reservoir near Woodland

SOLUTIONS FOR PROBLEMS AND NEEDS

(Photo by Washington State Dept. of Commerce and Economic Development)

SOLUTIONS FOR PROBLEMS AND NEEDS

Applicability of USDA programs and projects in achieving solutions to water and related land resource problems in Southwestern Washington has been evaluated in relation to types of problems which exist in each of 125 small watersheds which comprise the Basin (Figure 1).[23/] Principal problems considered were erosion and sedimentation, flooding (urban and agricultural), and agricultural water management as related to needs for drainage and irrigation. Needs related to rural water supply and to non-agricultural water management problems associated with municipal-industrial water supply, recreation, fish and wildlife development and water quality control, were also considered.

Applicability of USDA Projects and programs in relation to problems and needs existing in small watersheds was grouped into the following categories:

I Early action (next 10-15 years) small watershed projects with greatest opportunity for success under provisions of P.L. 83-566 as amended, combined with RC&D project measures, where eligible, and ongoing USDA programs.

II Later action small watershed projects under P.L. 83-566 authority in conjunction with RC&D project measures, where eligible, and ongoing USDA programs.

III Projects of small informal groups with or without USDA assistance and of governmental subdivisions such as counties, municipalities, flood control districts, drainage districts, etc., in conjunction with ongoing USDA programs.

IV Programs and projects of landowners installed independently, with or without USDA assistance.

V Completed projects which largely satisfy needs, or have no significant problems.

At present, RC&D project measures are eligible only in Grays Harbor, Pacific, and Wahkiakum Counties, affecting portions of Olympia, Chehalis, and South Coastal subbasins.

23/ SCS data supporting "Washington Soil and Water Conservation Needs Inventory," April 1970.

Water and related land resource problems and needs in 15 watersheds (Category I) were judged to be such that primary solutions to major problems would be best achieved through early action PL-566 small watershed projects or RC&D project measures, where eligible. In an additional 23 watersheds (Category II), later action PL-566 small watershed projects or RC&D project measures, where eligible, would be needed. Projects of governmental subdivisions, and of informal groups of landowners, were considered the most appropriate means of solving major problems in 49 watersheds (Category III); and in 23 watersheds (Category IV) actions of individual landowners assisted by ongoing USDA and related programs would be adequate in resolving water and related land resource problems and needs. Fifteen small watersheds (Category V) do not have significant problems, or major needs have been largely satisfied by the completion of watershed projects. In all watersheds, it is assumed that ongoing programs carried out by federal, state, corporate and private landowners are compatible with proposed USDA projects and projects of informal groups and government entities, and that they will continue as in the past.

Projects within the province of non-USDA agencies, such as flood protection measures on the main stem of larger rivers, beach and shore protection, and large irrigation projects, will also contribute to the overall solution of water and related land resource problems and needs in Southwestern Washington.

Table 67 provides a display of small watersheds of Southwestern Washington in relation to principal actions needed to solve water and related land resource problems as noted above.

Table 67 - Principal Means for Solving Water and Related Land Resource Problems and Needs by Small Watersheds Comprising Southwestern Washington.

Actions Needed to Solve Water and Related Land Resource Problems and Needs	Subbasins of Southwestern Washington				
	Olympic	Chehalis	[illegible]	Cowlitz	Lewis
I - Early action PL 566 small watershed projects combined with RC&D Project-1/ measures and ongoing USDA programs.		6-3 Cloquallam River 6-4 Newman Cr 2/ 6-14 Salzer Cr 0-118 Westport Area 0-119 Grayland 6-6 Skookumchuck River 2/	0-74 Wallicut River 0-75 Chinook Area 0-127 S. Fork Willapa R. 0-128 Cannon Creek 2/ 0-137 Bear River	23-10 Lacamus Creek 23-15 Lexington Area	0-59-1 Burntbridge Ck. 0-60 Salmon Creek
II - Later action PL-566 small watershed projects combined with RC&D project measures and ongoing USDA programs.	0-87 Pysht R. 0-88 Clallam	6-7 Stearns Cr 6-8 South Fk. Chehalis R. 6-17 Black R. 6-18 Oakville-Elma Area	0-66 Puget Isl. 0-69 Skamakawa River 0-70 Grays R. 0-72 Deep R. 0-119-1 Grayland 0-121 Tokeland 0-122 North River 0-126 Willapa R. 0-140 Long Beach	23-3 Cowlitz R. above Kosmos 23-6 Cowlitz R. above Mossy R. 23-7 Cowlitz R. 23-19 Beuna Vista 23-21 Coweman R.	0-57 Fifth Pl. Cr. 0-61 Ridgefield Area 0-62 Woodland Area
III - Projects of governmental entities or small informal groups combined with programs of individual landowners assisted by USDA.	0-98 Hoh River 0-99 Queets R. 0-101 Quinault River 0-105 Moclips R. 0-106 Copalis R. 0-110 Ocean City Area	6-1 Wynoochee R. 6-2 Satsop R. 6-5 Newaukum R. 6-9 W. Fork " 6-11 Hope Cr. 6-12 Deep Cr. 6-13 W. Chehalis Area 6-15 Lincoln Cr. 6-19 S.Side Chehalis R. 0-109 Humptulips River 0-112 Wishkah R. 0-113 Hoquiam R. 0-114 Grass Cr. 0-116 Johns R. 0-117 Elk R. Area	0-64 Coal & Mosquito Cks. 0-67 Elokamin Cr. 0-68 Nelon & Alger Cks. 0-71 Crooked Cr. 0-73 Grays Bay 0-120 Cedar R. 0-123 Smith Cr. 0-124 Ward Cr. 0-125 Willapa Flats 0-129 N. Nemah River 0-139 Salmon Cr.	23-1 Upper Cowlitz R. 23-2 Johnson Cr. 23-5 Tilton R. 23-5-1 Lake Cr. 23-9 Winston Cr. 23-12 S. Fork Toutle R. 23-13 Salmon Cr. 23-14 Olequa Cr. 23-16 W. Castle Rock 23-17 Ostrander Cr. 23-18 Lower Toutle River	22-3 Lower Lewis R. 22-4 E. Fork " 0-55 Columbia R. Skamania 0-56 Washougal River 0-59 Vancouver Area
IV Programs and projects of individual landowners carried out independently or with USDA assistance.	0-84 Sutherland-Crescent Bay Area 0-85 L. Crescent-Lyre R. 0-86 Deep Ck-Twin R. 0-89 Hoko River 0-90 Soqiu River 0-92 Sooes River 0-93 Osotte Lake 0-94 West Coast Strean 0-95 Quillayute River 0-107 Joe Creek	6-10 Elk Creek 6-16 Scatter Cr.	0-65 Abernathy Creek 0-130 Middle Nemah R. 0-131 S. Fork " " 0-132 Long Island 0-133 Clearwater R. 0-134 Elsworth & Smith Ck. 0-135 Lower Naselle R. 0-136 S. Fork Naselle R. 0-138 Naselle River	23-4 Cispus River 23-11 Upper Toutle R.	
V - Erosion, flooding & drainage problems are not significant or PL 566 watershed projects have been completed.	0-91 Neah Bay 0-96 Cedar Cr. 0-97 N.W.Coastal Creeks 0-100 Little Cr. 0-103 Camp Cr. 0-104 Wreck Cr. 0-108 Boone Cr. 0-102 Raft River	0-111 N. Bay Peninsula 0-115 S.E. Grays Harbor		23-8 Green River 223-20 Silver Lake 3/	22-1 Upper Lewis R. 22-2 Middle " " 0-58 Lacamus Cr. 3/

1/ Applicable at present only in Grays Harbor, Pacific & Wahkiakum Counties.
2/ Two projects in watershed (see Table 69).
3/ Completed P.L. 566 small watershed projects.

Solutions to primary problems resulting from types of principal actions proposed are summarized in Table 68. This table shows the estimated percentage of the problem corrected, on an area basis, by each type of action proposed.

Table 68. Results of Actions to Satisfy Water and Related Land Resource Problems.

Type of Problem	Types of Action			
	Early Action Small Watershed Projects	Later Action Small Watershed Projects	Projects of Small Landowner Groups & Governmental Subdivisions	Ongoing Programs of Public, Priv. & Corp Landowners
	Percent			
Erosion & Sedimentation	5	5	15	75
Urban Flooding	15	15	65	5
Agricultural Flooding	10	20	60	10
Drainage	10	15	40	35
Irrigation	10	10	15	65

Source: SCS data supporting "Washington Soil and Water Conservation Needs Inventory," April 1970.

"EARLY ACTION" PROJECTS

To assist in effecting solutions to water and related land resource problems, the U.S. Department of Agriculture, through the Soil Conservation Service and the Forest Service, has identified 18 separate projects within 15 small watersheds which could be implemented under provisions of P.L. 83-566 during the next 10-15 years (Table 69). Eight proposed projects are in the Chehalis subbasin; six in the South Coastal subbasin; two in the Cowlitz subbasin; and two in the Lewis subbasin. Twelve projects are multipurpose types, and all would involve structural and possibly nonstructural measures in addition to watershed land treatment, to reduce erosion and sedimentation and improve water quality. Most would provide benefits to fish and wildlife and recreation, as appropriate. Table 69 provides location information, generalized cost estimates, and major purposes proposed for each. Brief information regarding these projects follows.

Chehalis Subbasin

China Creek (6-6) – This project site is one of two in the Skookumchuck Watershed located in northwest Lewis County. The China Creek subwatershed is bounded on the north by the Skookumchuck River, on the south by Salzer Creek watershed, and on the west by the Chehalis River. China Creek flows from northeast to southwest, passing through the city of Centralia before emptying into the Chehalis River.

The project would be designed for flood prevention on urban lands. The area included in this watershed contains about 4,300 acres, of which 2,000 acres are urban or rural nonfarm, 1,800 acres are forest, and 530 acres are cropland and miscellaneous.

The works of improvement would consist of 5,000 feet of improved channel east of Centralia and 2,500 feet of 60-inch buried concrete pipe. The concrete pipe would divert floodwaters from China Creek and carry them into Skookumchuck River. A flapgate would be placed on the end of the pipe to prevent Skookumchuck River from backing into the pipe. Only floodflows would be diverted. Normal flows would continue down China Creek.

Installation cost of structural measures is estimated to be $498,000. The federal share would be $399,000, and the local share $99,000. Benefits from damage reduction are estimated to provide a benefit-cost ratio of 1.2 to 1. To achieve benefits made possible by structural works and other management, local interests will install necessary land treatment measures for erosion control and flood management estimated to cost $33,000; urban drainage estimated to be $75,000; and forest protection and management practices, including technical assistance, estimated at $5,000; for a total of $113,000. The total cost of installing the structural and land treatment measures is estimated at $611,000.

Table 69. Early Action Watershed Projects by Subbasin, Southwestern Washington.

Subbasin and Project	Watershed Number [a]	Structural Measures Cost	PURPOSES					
			Flood Prev.	Rec.	Drainage	M&I Water	Streamflow Augmentation	Fish & Wildlife
CHEHALIS								
McCleary Area [b]	6-3	678,000	x	x		x	x	x
Newman Creek [b]	6-4	2,344,600	x	x		x	x	x
Vance Creek	6-4	202,100	x					
Coffee Creek [b]	6-6	1,500,000	x	x		x	x	x
China Creek	6-6	498,000	x					
Salzer-Coal Creek [b]	6-14	3,927,000	x	x		x	x	x
Westport Area	0-118	291,500	x					
North Grayland	0-119	564,000	x					
SOUTH COASTAL								
East South Bend	0-128	447,000	x					
West South Bend	0-128	167,000	x					
Chinook	0-75	299,000	x		x			
Wallicut	0-74	215,000	x		x			
So.Fork Willapa River [b]	0-127	1,731,000	x	x		x	x	x
Bear River (A'Chote) [b]	0-137	7,467,000		x		x	x	x
COWLITZ								
Lacamas Creek	23-10	1,731,000	x		x			
Lexington Area	23-15	722,000	x					
LEWIS								
Burntbridge Creek	0-59-1	2,047,000	x					
Salmon Creek	0-60	3,433,000	x		x			
Total Cost		$27,709,200						

[a] Refer to Figure 1 for location map.
[b] Irrigation could become an additional purpose for these projects if the need arises.

Installation of the project would bring about a variety of effects. A reduction of flooding would prevent disruptions of municipal as well as business services. Losses to culverts, bridges, and roads would be reduced, along with reduction of traffic delays and detours. Health conditions and vector control would be improved within the urban area affected by flooding.

Land occupied by the new channel would be removed from its present use and made unavailable for any future development. About three acres of Type I and one acre of Type II wetlands would be eliminated. There would be noise and dust pollution during construction, along with interruptions to traffic.

Coffee Creek Watershed (6-6) – This project site, the second in the Skookumchuck Watershed, is located in northern Lewis County and southern Thurston County. The watershed begins in 600-foot-high hills about 6 miles north of the city of Centralia. The southern boundary of the watershed is north Centralia, where Coffee Creek runs into the Skookumchuck River.

The project would be designed for flood prevention on urban and agricultural lands, with recreation, supplemental irrigation, and municipal and industrial water supply as potential uses if the reservoir is built. The area included in this watershed contains 7,700 acres, of which 4,500 acres are forest, 1,830 acres are urban and rural nonfarm, 1,200 acres are hay and pasture, and 170 acres are roads, railroads, and miscellaneous uses.

Works of improvement included in this project are a dam and reservoir, channel work, a gated outlet structure, and some small dikes. The proposed dam and reservoir would be 2 miles north of the Centralia city limits. The dam would be approximately 25 feet high and 800 feet long. The reservoir would form a lake with 350 surface acres and would hold 2,300 acre-feet of water. Half of this storage would be needed for flood prevention. The other half could be used for recreation or other uses. Three miles of channel below the dam would be modified in those sections where the grade or capacity is not sufficient. A gated outlet structure would be placed at the confluence with the Skookumchuck River to prevent backflow from the river. Small dikes would be placed on each side of the structure to prevent overland backflow into the lower flood plain.

Structural measures installation cost is estimated to be $1,720,000, of which the federal share would be $1,201,000 and the local share $519,000. Benefits from damage reduction and recreation are estimated to provide a benefit-cost ratio of 3.0 to 1. To achieve benefits made possible by the structural works and other management, local interests would install necessary land treatment measures for erosion control and flood management estimated at $150,000, drainage measures estimated at $50,000, and forest protection and management practices estimated at $15,000, for a total of $215,000. Total cost of the project is estimated at $1,935,000.

Reduction of damages to pasturelands would raise the income of two full-time farmers. Flood damages to approximately 100 homes would be greatly reduced, thus eliminating worry, personal hardships, and expenses that occur during flooding. Losses to roads, bridges, and culverts would be eliminated, saving the taxpayers money as well as avoiding the inconvenience of detouring around washed-out or flooded roads.

The 350-acre reservoir would generate a new fishery within the Chehalis-Centralia area and provide for about 140,000 visitor-days per year for all types of recreation. Health conditions and vector control would be improved in those urban areas affected by floodwaters from Coffee Creek.

Unfavorable effects of the project as proposed would include the loss of 300 acres of Type I and 70 acres of Type II wetlands, mostly located within the reservoir site or just below the dam.

About 60 acres of wildlife habitat would be lost in the reservoir site and along the channel leading from the dam to the Skookumchuck River. There would be noise and dust pollution during construction. The reservoir would require the relocation of three part-time farms and one full-time farm, including buildings and people. About three-quarters of a mile of roadway within the reservoir site would have to be relocated.

McCleary Area (6-3) – This project site is located in the northeast corner of Grays Harbor County in the Cloquallam River Watershed. The city of McCleary, located at the southern end of the watershed, lies adjacent to State Highway 401, 20 miles west of Olympia and 30 miles east of Aberdeen. A small branch of the East Fork of Wildcat Creek flows in a covered pipe through McCleary.

The project would be designed for flood prevention in urban areas, and recreational use of the planned reservoir. The area included in this watershed contains 875 acres, of which 590 acres are forested, 225 acres are in urban use, and 60 acres are in hay and pastureland.

There are two works of improvement alternatives for this watershed, depending upon the objectives of local people.

The first alternative would involve a dam and reservoir and could include flood prevention, recreation and M&I water, as project purposes. The dam would be 40 feet high and 500 feet long. The reservoir would hold 300 acre-feet and form a lake about 30 acres in size. Location of the dam and reservoir would be about 1 mile east of McCleary.

Installation cost is estimated to be $678,000, with the federal share estimated at $503,250, and the local share, $174,750. Benefits from damage reduction and recreation are expected to provide a benefit-cost ratio of 1.5 to 1.

The second alternative would be a 72-inch buried pipe through the town of McCleary. This alternative would be for flood prevention only. Length of pipe would be about 1,800 feet.

Installation cost is estimated to be $387,000, of which the federal share would be $313,000, and the local share, $74,000. Benefits from damage reduction are estimated to provide a benefit-cost ratio of less than 1 to 1. More study is needed to determine whether this alternative would be feasible.

To achieve benefits made possible by either alternative and other management, local interests would install necessary land treatment measures for erosion control and flood management estimated at $6,000; urban drainage measures at $20,000; and forest protection and management practices, including technical assistance, estimated at $10,000; for a total of $36,000. Thus, total cost of alternative one would be $714,000 and total cost of alternative two would be $423,000.

Installation of either alternative would being about a number of effects. Flood damages to business and residential areas within McCleary would be eliminated. The personal hardship and expense that occur to property owners during flooding would be avoided. Losses to roads and culverts would be reduced, as well as the inconveniences of detouring around washed-out or flooded roads. Health and vector control in flood prone areas of McCleary would be improved.

The following effects would apply only to alternative one. The 30-acre reservoir would generate a new fishery almost within the town of McCleary. The reservoir would also provide for about 30,000 annual visitor-days per year for all types of recreation, including swimming and picnicking.

There would be a loss of about 8 acres of Type I and 2 acres of Type II wetlands. There would be a loss of 30 acres of pasture, and the relocation of one part-time farmer.

Vance Creek (6-4) — This project site is one of two identified in the Newman Creek Watershed, located in the northeast section of Grays Harbor County. The watershed is bounded on the south by the Chehalis River, on the east by the city of Elma, and on the west by Newman Creek. Aberdeen is about 20 miles to the west, and Olympia is 30 miles to the east.

The project would be designed for flood prevention on urban and agricultural lands. The area included in this watershed contains about 6,230 acres, of which 3,825 acres are forest, 1,700 acres are hay and different types of pasture, and 705 acres are urban and rural nonfarm.

Works of improvement would consist of a diversion structure and a channel. The structure would divert floodflows from Vance Creek down the 5,000 feet of diversion channel, and around agricultural and urban areas. Normal flows would continue to flow through the Vance Creek channel.

Installation cost of structural measures is estimated to be $202,100, of which the federal share would be $144,600 and the local share $57,500. Benefits from damage reduction are estimated to provide a benefit-cost ratio of 1.6 to 1. To achieve benefits made possible by the structural works and other management, local interests would install necessary land treatment measures for erosion control and flood management estimated at $50,000, drainage measures estimated at $80,000, and forest protection and management practices estimated at $5,000, for a total of $135,000. The total cost of installing the structural and land treatment measures is estimated at $337,100.

Project measures would reduce flood damages to several residential developments and pasture and haylands. Inconveniences and financial hardships caused by flooding would be eliminated. Health conditions and vector control would be improved in the urban areas affected by floodwaters from Vance Creek. Losses to culverts and roads would be eliminated, preventing traffic delays and detours.

Land occupied by the new channel would be removed from its present use and made unavailable for any future development. About 20 acres of Type I and five acres of Type II wetlands would be eliminated.

Newman Creek (6-4) – This project site, the second in the watershed, is located in the northeast section of Grays Harbor County. The watershed is bounded on the south by the Chehalis River, on the east by Vance Creek and the city of Elma, and on the west by the Satsop River drainage. Aberdeen is about 17 miles to the west, and Olympia is 33 miles to the east.

The project would be designed for flood prevention on agricultural and urban lands, with water-based recreation as a major purpose if the alternative proposing the dam and reservoir is selected. The area included in this watershed contains about 8,130 acres, of which 4,985 acres are in forest, 2,427 acres are in hay and different types of pasture, 440 acres are in urban and rural nonfarm uses, and 278 acres are in roads and miscellaneous uses.

There are three works of improvement alternatives for this watershed, depending upon objectives of local people. Only the third alternative has been evaluated in terms of benefit-cost analysis and effects.

The first alternative would involve a diversion structure and channel. This channel would be about 5,000 feet long and would divert floodflows

out of Newman Creek from 1 mile north of Highway 410 as far south as the old highway. Here, flows would again re-enter Newman Creek channel. Normal flows would continue in the Newman Creek channel. These structural measures are estimated at $144,450, with the federal share being $123,100, and the local share, $21,350. This alternative would protect about 150 acres of agricultural land.

The second alternative would also involve a diversion structure and diversion channel. This diversion channel would be 16,000 feet long and would divert floodflows from where Newman Creek leaves the hills until it joins with Vance Creek. Normal flows would continue in the present Newman Creek channel. Cost of these structural measures is estimated to be $460,300, with the federal share being $431,600 and the local share, $28,700. This alternative would protect about 600 acres of agricultural and urban built-up land.

The third alternative would include a dam and reservoir, and would cover flood damage reduction and recreation. Municipal and industrial water supply would also be possible. The dam would be about 60 feet high, with a top length of 800 feet. The reservoir would store 6,000 acre-feet, and would have a surface area of 600 acres. Cost of this alternative is estimated at $2,344,600, with the federal share being $1,633,800, and the local share, $710,800. Benefits from damage reduction and recreation are expected to provide a benefit-cost ratio of 1.3 to 1. To achieve benefits made possible by the structural works and other management, local interests would install necessary land treatment measures for erosion control and flood management estimated to be $200,000, drainage measures $100,000, and forest protection and management practices $10,000, for a total of $310,000. Total cost of the project would be $2,654,600.

Reduction of floodwater damages to pasture and cropland would raise the income of three full-time farms and reduce the financial burden on several part-time farmers.

The 600-acre reservoir would generate a new fishery within the Olympia-Aberdeen-Hoquiam area and provide for about 78,000 visitor-days per year for all types of recreation. Health conditions and vector control would be improved in those areas affected by floodwaters from Newman Creek.

Unfavorable effects of alternative three would include the loss of 350 acres of Type I wetlands and 120 acres of Type II wetlands. Most of the wetlands are located below the damsite.

About 650 acres of existing wildlife habitat would be lost, due to construction at the damsite and filling of the reservoir. The reservoir would require the relocation of four part-time farmers and one full-time farmer. Any existing coho salmon spawning grounds above the dam would be eliminated.

Salzer-Coal Creek (6-14) — This project site is located east and north of the city of Chehalis and east and south of the city of Centralia, in Lewis County. Olympia is approximately 26 miles north of the watershed, and the Kelso-Longview area is about 40 miles to the south. Coal Creek flows into Salzer Creek, which in turn joins the Chehalis River just west of the Centralia-Chehalis area.

The project would be designed for flood prevention in urban and agriculture areas, and recreational use of the reservoir. Additional municipal and industrial water for the Chehalis-Centralia area could be added as a project purpose. The area included in this watershed is 16,917 acres. Land use includes forest, 11,502 acres; cropland, 2,651 acres; pasture, 604 acres; urban, 1,303 acres; rural nonfarm, 249 acres; and miscellaneous uses, 608 acres.

Works of improvement would consist of a dam and reservoir, diking, pumping plants, and some channel work. The dam would be 65 feet high and 500 feet long. This structure would impound about 10,000 acre-feet of water with a maximum surface area of 375 acres. About 4 miles of dikes and two pumping plants would be installed. These pumping plants would have a capacity of 190 cubic feet per second. Approximately 4,800 feet of channel would need additional channel capacity.

Project measures would reduce floodwater damages to cropland and residential and business property. Losses to roads and bridges would be reduced. The 330-acre reservoir would increase water-based recreation by about 143,000 vistior-days each year. The trout fishery in the watershed would be greatly improved. Unfavorable effects that could occur include the loss of approximately 350 acres of Type I wetlands. About 330 acres of wildlife habitat would be lost under the waters of the reservoir. Spawning ground for coho salmon on the South Fork of Salzer Creek above the dam would be eliminated.

Installation cost of structural measures is estimated to be $3,927,245, of which the federal share would be $3,110,315 and the local share, $816,930. To achieve benefits made possible by the structural works and other management, local interests would install necessary land treatment measures for erosion control and flood management estimated to be $20,000; drainage measures $100,000; and forest protection and management practices, including technical assistance, $30,000; for a total of $150,000. The total cost of project installation is estimated at $4,077,245.

Westport Area (0-118) — This project site is located in southwest Grays Harbor County. The area is flanked on the north and east by Grays Harbor, and on the west by the Pacific Ocean. Aberdeen is approximately 20 miles to the northeast, and Raymond is about 35 miles to the southwest.

The project would be designed for flood prevention in urban residential areas. The area included in this watershed contains about 3,039 acres, of which 1,086 acres are classified as urban, 900 acres are beach and tidelands, 300 acres are in forest, 650 acres are classified as barren land, and the rest is in native pasture and other miscellaneous uses.

Works of improvement would include 12,000 feet of improved flood control channel and a new outlet structure, including tide gates and pumping facilities, along with a water control structure on the north end of Westport Lake. The channel would begin in the vicinity of Westport Lake and continue downstream to the present outlet structure. The outlet structure would have two tide gates, and two pumps with a pumping capacity of about 8 cubic feet per second. The project is designed to remove floodwaters from low-lying areas in the Westport watershed.

Estimated costs for installation of structural measures would be $291,500, with the federal share being $197,000 and the local share $94,500. Benefits from damage reduction are estimated to provide a benefit-cost ratio of 1.5 to 1. To achieve benefits made possible by the structural works and other management, local interests will install necessary land treatment measures for erosion control, flood management and drainage estimated to cost $25,000. Total cost of installing the structural and land treat measures is estimated to be $344,000.

Project measures would reduce floodwater damages to summer and full-time residences within the watershed. It would prevent damages to a private campground and help alleviate problems caused by a high water table.

Unfavorable effects of the project include the loss of 2 acres of Type VII wetlands. About 2 acres of wildlife habitat along the channel would be removed during construction. There would be noise and dust pollution during construction as well as interruptions to traffic.

North Grayland (0-119) — This project site is located in the extreme southwest corner of Grays Harbor County. The watershed is bounded on the north by the Westport area, on the west by the Pacific Ocean, and on the south by the northern edge of Pacific County. The city of Westport is 5 miles north of the watershed.

The project would be designed for flood prevention on agricultural lands. The area included in this watershed contains about 5,450 acres,

of which 2,560 acres are forest, 1,565 acres are beach and tidelands, 458 acres are classified as urban, 738 acres are cranberries, hay, and pasture; and the rest is in miscellaneous uses.

Works of improvement would consist of 4.5 miles of improved channel through the agricultural area, and an outlet structure with tide gates. The tide gates would prevent incoming tides from forming a blockage that would not allow floodwaters to drain.

Estimated costs for installation of structural measures would be $564,000, with the federal share being $482,000 and the local share $82,000. Benefits from damage reduction are estimated to provide a benefit-cost ratio of 1.2 to 1. To achieve benefits made possible by the structural works and other management, local interests would install necessary land treatment measures for erosion control and flood management estimated to cost $50,000 and drainage measures $45,000, for a total of $95,000. Total cost of structural and land treatment measures is estimated to be $659,000.

Floodwater removal from cranberry lands would allow proper water management on bogs, which is essential for sustained quality production. Damages and hardships associated with flooding would be eliminated for homeowners in the area. Standing water would be removed from Twin Harbors State Park, allowing for full utilization of park facilities. Vector and health problems associated with standing water and high water tables would be reduced.

Approximately 7 acres of Type VII wetlands would be eliminated. About 25 acres of wildlife habitat would be removed during construction of the channel and outlet structure, and there would be noise and interruptions to traffic during that time.

South Coastal

East South Bend Watershed (0-128) — This project site is one of two identified in the Canon Creek Watershed located in the northern portion of Pacific County. It includes a sizable area of the city of South Bend. The watershed is tributary to Willapa River just before the river enters Willapa Bay.

The project would be designed for flood prevention on urban lands. The area included in this watershed contains about 424 acres; 280 acres are in commercial and urban development and 144 acres are in woodland. The average slope is 25 percent, and the highest point is 400 feet above mean sea level.

Works of improvement would consist of 2,660 feet of diversion ditch, diking along U.S. Highway 101, a pumping plant with 200 cubic feet a second capacity with tide gates, and an upgrading of the city storm sewer system. The diversion ditch would divert runoff from the wooded slopes directly into the improved surface drain system. Diking would protect the community from being inundated by high tides from the ocean. The pumping plant would allow runoff water to be pumped into the river during periods of high tides.

Installation cost of structural measures is estimated to be $447,000. The Department of Agriculture could share only in that portion of the cost having to do with removing floodwaters from existing urban areas. USDA does not have authority to do project work involving ocean waters. Therefore, this project would have to be done in conjunction with the Corps of Engineers or some other agency having authority to do required diking and riprapping. Thus the federal share of structural measures, excluding the portion that could not be done by USDA, would be $236,500 and the local share $45,700. Estimated cost of $165,000 for diking and riprapping would have to be cost-shared under the procedures of the agency that could do the work.

Benefits from damage reduction are estimated to provide a benefit-cost ratio of 1.3 to 1. To achieve benefits made possible by the structural works and other management, local interests would install necessary land treatment measures for erosion control and flood management estimated to cost $5,000, urban drainage $10,000, and forestry management practices $2,500, for a total of $17,500. Total cost of the project is estimated to be $464,500.

The measures proposed would produce sedimentation during construction and revegetation. Salt water damage to vegetation in the community from high tides has been low, but would be eliminated.

Approximately 3 acres of wetlands near the outlet of the surface drainage system would not be physically affected by the structural measure, but it is possible that reduction of the flooding hazard would encourage land filling and urban-commercial development of this area. Improvement of the main stem surface drain through this area would have temporary adverse effects on wildlife habitat in the wetland.

The overall effect of reduced flooding to the community would be a lessening of flood risks and loss of business time. Property values and the overall appearance of the area would improve. The general social and economic well-being of the community would be benefited.

There would be noise and dust pollution during construction, along with interruptions to traffic.

West South Bend Watershed (0-128) – This project site, the second in the Canon Creek Watershed, is located in the northern portion of Pacific County and includes the western portion of the city of South Bend. The watershed is tributary to the Willapa River just before it enters Willapa Bay.

The project would be designed for flood prevention on urban lands. The area included in this watershed is approximately 1,600 acres, of which 1,400 acres are forest land and 200 acres are urban built-up lands.

Planned works of improvement would include two sections of buried concrete pipe, two small earthen dams, and small dikes with drainage structures. The main section of pipe would be 72 inches in diameter and 630 feet long, and would replace the present wood-lined channel. A small earthen dam would be installed south of this pipe. An adequate outlet for Church Draw would be provided by a 600-foot-long, 36-inch diameter pipe, with a small earthen dam across the outlet. Dikes with drainage structures would protect three homes and a small sawmill in the wetland area.

Installation cost of structural measures is estimated to cost $167,000, with the federal share being $142,000 and the local share $25,000. Benefits from damage reduction are estimated to provide a benefit-cost ratio of 3.1 to 1. To achieve benefits made possible by structural works and other management, local interests would install necessary land treatment measures for erosion control and flood management estimated to cost $10,000, urban drainage $10,000, and forest protection and management practices $2,500, for a total of $22,500. Total cost of installing the structural and land treatment measures is estimated to be $189,500.

Disruption of the natural environment caused by noise and dust and interruptions to traffic would occur during the 2-3 month construction period.

The alders and blackberry vines lining 600 feet of wood-lined floodway would be removed during installation of the 72-inch pipe, resulting in a loss of songbird habitat. However, there is extensive habitat available, so this loss would not have a measurable effect upon the bird populations. All dikes, dams, and disturbed areas would be revegetated.

The watershed environment would be benefited by removal of the wood-lined floodway. A safety hazard would be removed and the threat of flooding reduced. Fish habitat would be improved, as access to the upper watershed would be insured through removal of the tide gate.

The Chinook River Watershed (0-75) – This project site lies in the southwest portion of Pacific County. The watershed is tributary to the Columbia River estuary and drains into the Columbia approximately 4 miles east of the Pacific Ocean. The city of Ilwaco lies about 3 miles west of the mouth of the Chinook River.

The project would be designed for flood prevention and drainage on agriculture and recreation lands. Total area of the watershed is 8,576 acres, with 5,800 acres in forest, 2,200 acres in hay and pasture, 350 acres in recreational homesites, and 226 acres in roads, water, and other uses.

Proposed structural works of improvement would include a floodwater diversion ditch with a low-flow structure inlet, channel system improvement for the conveyance of excess water, and trash racks. The diversion channel would be about 4,600 feet long and would divert water from the upper watershed directly into the Columbia River. Logs, sediment deposits and other debris would be removed from about 15,000 feet of river channel. All channel work would be accomplished by working from one side of the channel only. Three trash racks would be added to the existing floodgates to protect them from floating debris.

Installation cost of structural measures is estimated to be $229,000, with the federal share estimated to cost $206,500 and the local share $92,500. Benefits from the project are expected to provide a benefit-cost ratio of 3.5 to 1. To achieve benefits made possible by structural works and other management, local interests would install necessary land treatment measures for erosion control and flood management estimated to be $25,000 with drainage measures $12,000, for a total of $37,000. Total cost of installing structural and land treatment measures is estimated to be $236,000.

Erosion rates would be reduced from 3 tons per acre to less than 1.5 tons per acre. This reduced erosion will also show up in reduction of sediment delivery rates at the floodgates.

Installation at the diversion canal would require 13 acres to be cleared for construction and maintenance works. Installation of control works on the highway crossing would allow water levels to be maintained through the summer months. This would provide 1.4 acres of open water for wildlife, and prevent overdraining of Type VI wetlands.

Dikes and spoil areas would be seeded to native grasses and shrubs. Spoil shaping would provide a location for a hiking trail through the park area.

The short-term effect upon the stream channel during the construction period would be increased water turbidity. An estimated 500 cubic yards of silt would be removed from the channel.

There are approximately 1,200 acres of farmlands which would benefit from an improved drainage outlet. In addition to the farmlands, 300 acres of recreational and urban areas would be benefited by a reduced water table.

Crop yields are expected to increase because of land treatment made practical by the drainage outlet improvements. Pasture yields would increase from two-thirds AUM to 10 AUM, with pasture being approximately 60 percent of the cropland. Hay would increase from 1 ton per acre to 5 tons per acre on the remaining cropland.

About 865 acres of Type I wetland would be eliminated as a result of the project. An additional 95 acres of Type II wetlands and 14 acres of Type VII wetlands would be lost. Construction of a diversion from the Chinook River through Type VI wetlands in Fort Columbia State Park would disturb these wetlands, but a water control structure would contribute to the preservation of this wetland and create an additional 1.4 acres of permanent open water.

Wallicut River Watershed (0-74) – This project site lies in the southwest portion of Pacific County. The city of Ilwaco lies about 1 mile west of the mouth of the Wallicut River. The Wallicut is tributary to the Columbia River approximately 2 miles east of the Pacific Ocean.
The project would be designed for flood prevention and drainage on agricultural and recreation lands. Total area of the watershed is 4,224 acres, of which 2,910 acres are forest, 679 acres, hay and pasture, 575 acres are to become recreational homesites, and 60 acres are roads, water, etc.

Planned works of improvement would include improving the channel system for conveyance of excess water and two additional floodgates to dispose of water. Logs, sediment deposits, and other debris would be removed from about 26,000 feet of channel. All channel work would be accomplished by working from one side only. Two floodgates, 60 inches in diameter, would be added, along with trash racks to protect the gates from floating debris.

Installation cost of structural measures is estimated to be $215,000, with the federal share $139,000 and the local share $76,000. Benefits from the project are estimated to provide a benefit-cost ratio of 2.8 to 1. To achieve benefits made possible by the structural works and other management, local interests would install necessary land treatment measures for erosion control and flood management estimated to cost $3,000 and drainage measures $30,000, for a total of $33,000. Total cost of installing structural and land treatment measures is estimated to be $248,000.

Land treatment and structural measures would prevent or reduce flooding of farms, and recreational and forest lands from 10 percent probability flood events, and reduce the area flooded from larger storms. The area benefited by the structural measures includes 542 acres of agricultural lands, 490 acres of forest lands, and 335 acres of recreational lands, all of which would be damaged from the 1 percent chance event without the project.

A maintenance and construction road must be cleared on the main branch of the Wallicut. This would require 1.8 acres of land. Water levels would be maintained so that water areas would not be reduced during construction.

Short-term effect of construction would be increased turbidity of the streams as displaced silts move downstream. Of about 3,100 tons of silt to be removed from the channels, about 90 tons would move with the water and enter Baker Bay on the Columbia River.

Land use in the flood plain is not expected to change as a result of project measures, but crop production rates would be higher. Principal crops would be primarily pasture (60 percent of the cropland) and hay (40 percent of the cropland).

All Type I wetlands within the watershed would be eliminated as a result of the project. An additional 125 acres of Type II wetlands and 33 acres of Type VI wetlands would be lost. Installation of headgates on outlet pipes would allow summer water to be held at a level compatible for plant growth. This would maintain water in the channel for fish and wildlife use.

South Fork Willapa River Watershed (0-127) – This project site is located in northwestern Pacific County. The South Fork flows in a northwesterly direction, entering the Willapa River near the city of Raymond.

The project would be designed for municipal and industrial water supply and recreation, with some flood prevention capacity also available within the reservoir. Other potential purposes could be irrigation and streamflow augmentation. The area included in this watershed contains 24,911 acres, of which 23,657 acres are forest, 498 acres are hay and pasture, 459 acres are urban and rural nonfarm, and 297 acres are tidelands and miscellaneous.

The works of improvement included in this project are a dam and reservoir, and a water supply distribution system. The proposed dam and reservoir would be 3 miles south of the Raymond city limits. The dam would be approximately 60 feet high and 800 feet long. The reservoir would form

a lake with 600 surface acres, and would hold 24,000 acre-feet of water. Approximately 2,500 acre-feet would be available for municipal and industrial water, 7000 acre-feet for flood water detention, and 14,500 acre-feet for recreation. Approximately 1 mile of 5-inch water line would be needed to transport water from the reservoir to the outskirts of South Bend and adjacent areas.

Installation cost of structural measures is estimated to be $1,731,000. The federal share would be $918,100 and the local share $812,900. Benefits from municipal and industrial water supply and from recreation are estimated to provide a benefit-cost ratio of 2.0 to 1. To achieve benefits made possible by the structural works and other management, local interests would install necessary land treatment measures for erosion and sediment control and flood management estimated to cost $75,000, and forest protection and management practices $23,000, for a total of $98,000. Total cost of the project is estimated to be $1,829,000.

The South Fork of the Willapa River supports populations of chinook, coho, and chum salmon, and steelhead and sea-run cutthroat trout. Important spawning areas for these species are known to exist in the lower South Fork from the reservoir site downstream, and in Rue Creek upstream from the damsite. Use of upstream spawning areas has not been precisely determined, but important runs of coho salmon, steelhead, and sea-run cutthroat trout ascend the stream. A dam constructed at the proposed site would block spawning migrations and destroy important spawning and rearing habitat. Since nongame fish inhabit the river system, periodic rehabilitation of the reservoir and upstream areas would be necessary to maintain a sport fishery.

The watershed is an important range for Roosevelt elk and black-tailed deer. Other species of wildlife inhabiting the area are blue and ruffed grouse, band-tailed pigeons, beaver, mink, and muskrat. Waterfowl use is concentrated near the mouth of Willapa River and in Willapa Bay. Migratory birds would utilize the proposed reservoir. About 600 acres of deer and elk range within the reservoir site would be lost.

A new fishery would be created in the lake, and 150,000 annual visitor-days would be provided by the reservoir. This would include boating, swimming, camping, and picnicking.

A new supply of high quality municipal and industrial water would be made available for the cities of Raymond and South Bend.

Bear River (A'Chote) Watershed (0-137) – This project site is located in southwestern Pacific County. Bear River begins in the Willapa Hills and flows in a northwesterly direction before outletting into the southern portion of Willapa Bay.

This project could be designed for a number of purposes, including municipal and industrial water supply and recreation, with irrigation and streamflow augmentation as other possibilities. The area included in this watershed contains 17,156 acres, of which 16,314 acres are forest, 527 acres are tidelands, 258 acres are hay and rotation pasture, and 57 acres are in miscellaneous uses.

There are two works of improvement alternatives for this watershed, depending upon the objectives of local people. Alternative one could provide municipal and industrial water and recreation, with irrigation and streamflow augmentation as potential purposes. Potential works of improvement would include a dam and reservoir, a balancing reservoir, and a water supply distribution system. The proposed dam and reservoir would be about 9 miles east of the Long Beach peninsula. The dam would be about 100 feet high and 630 feet long. The reservoir would form a lake with 250 surface acres, and would hold 8,000 acre-feet of water. Approximately 2,000 acre-feet would be used for municipal and industrial water, with the remainder for recreation. A dam 160 feet high and 630 feet long would store 16,600 acre-feet of water. The additional 6,600 acre-feet could be used for irrigation and streamflow augmentation. Irrigation aspects have not been evaluated. Nearly 11 miles of variable size pipe would be needed to transport water to a balancing reservoir 2 acres in size, west of Ilwaco. Approximately 16 miles of variable size pipe would be needed to transport water from the balancing reservoir throughout the peninsula.

Alternative two would replace the dam and reservoir with a diversion structure. All other measures in alternative one would also be necessary in alternative two. This alternative would be entirely for municipal and industrial water supply. Cost of structural measures for this alternative is expected to be $5,350,000, all of which would be local cost.

Structural measures installation cost of alternative one is estimated to be $7,467,000, of which the federal share would be $1,125,750 and the local share, $6,341,250. Benefits from municipal and industrial water and recreation are estimated to provide a benfit-cost ratio of 1.4 to 1. To achieve benefits made possible by the structural works and other management, local interests would install necessary land treatment measures for erosion and sediment control estimated to cost $25,000 and forest protection and management practices estimated at $15,000, for a total of $40,000. Total cost of alternative one is estimated to be $7,507,000.

Three species of Pacific salmon utilize Bear River and its tributaries during the fresh-water phase of their life. Significant runs of chum and chinook salmon utilize the main stem for spawning and rearing, while sizable numbers of silver salmon use the main stem as well as the tributaries.

Bear River runs of salmon contribute substantially to the Willapa Bay commercial fishery.

From information available at this time, estimated numbers of salmon utilizing Bear River at present are 250-500 fall chinook, 1,000-2,000 silvers, and 5,000-10,000 chum salmon. For each respective salmon specie escaping to spawn, the following average numbers are caught by the various sport and commercial fisheries: 4 chinook, 3 silvers, 1-2 chums.

A dam on Bear River would eliminate any spawning grounds located above the damsite. A water storage impoundment on Bear River could influence the temperature and flow regimes and possibly affect the success of spat setting of Pacific oysters in southern Willapa Bay. About 320 acres of wildlife habitat would be flooded out by the reservoir, including deer and elk range.

A new lake fishery would be created. The reservoir would provide about 20,800 annual visitor-days of recreation to boaters and fishermen.

A new supply of high-quality municipal and industrial water would be made available for Ilwaco and the entire Long Beach peninsula.

Land treatment measures could reduce sediment in southern Willapa Bay, thereby improving the shellfish resource.

Costs of adding municipal and industrial water supply as a purpose must be paid for by local people under present authorities. USDA assistance is limited to low-cost loans or advancements to be repaid in not more than 50 years from the date when the principal benefits first become available.

Cowlitz Subbasin

Lacamas Creek Watershed (23-10) – This project site is located in southwest Lewis County. The watershed originates in hills of approximately 1,000 feet elevation. The creek flows in a southwesterly direction, and has several other streams tributary to it before its confluence with the Cowlitz River 2 miles east of Vader.

The project would be designed for flood prevention and drainage on agricultural lands. The watershed contains 26,214 acres, of which over 17,000 acres are forest, 8,000 acres are hay and pasture, and the remainder is in numerous other uses.

Works of improvement would consist of 23 miles of channel work on existing channels of Lacamas Creek and its tributary streams. This channel work would require the modification or possible reconstruction of two highway bridges, several culverts, and six farm bridges.

Installation cost is estimated to be $1,176,000, of which the federal share would be $848,000 and the local share $328,000. Benefits from damage reduction are estimated to provide a benefit-cost ratio of 1.6 to 1. To achieve benefits made possible by the structural works, local interests would install necessary land treatment measures for erosion control and flood management estimated to cost $15,000, agricultural drainage $60,000, and forest protection and management practices $10,000, for a total of $85,000. Total cost of installing structural and land treatment measures is estimated to be $1,261,000.

Reduction of flooding would permit the seasonal planting and cultivation of farm crops and prevent agricultural damages caused by inundation. This, in turn, would raise incomes and improve the well-being of those people who suffer floodwater damages. Damage to culverts, bridges and roads, along with traffic delays and detours, would be reduced, lessening county and state maintenance costs and improving traffic corridors. Health conditions and vector control would be improved within the area affected by flooding.

About 30 acres of Type I and Type II wetlands would be eliminated. There would be noise and dust pollution during construction, and interruptions to traffic. About 40 acres of brush and trees would be destroyed during construction.

Lexington Watershed (23-15) – This project site lies about 2 miles north of Kelso on the west side of the Cowlitz River. The watershed area is drained by two streams, the larger of which is known as McCorkle Creek. The smaller stream has no name. The upper portion of the watershed begins in hills approximately 1,000 feet in height, and the watershed drains eastward to a relatively flat portion of the Cowlitz River flood plain. The flat-land portion of the watershed is approximately 500 acres in size and is almost totally urbanized.

The project would be designed for flood prevention on urban lands. The watershed contains 9,292 acres, of which 6,000 are forest and 1,500 acres are cultivated. Over 1,000 acres of the watershed are classified as urban. The remainder of the watershed is in various other uses.

Works of improvement would consist of 78,000 lineal feet of compacted dike and 58,000 lineal feet of channel work on existing channels to convey floodwaters to two gated outlet structures which would prevent high flows of Cowlitz River from backing into urban areas. The improved channels would divert floodflows from the hills into channels leading to gated outlets.

Installation cost is estimated to be $722,000, of which the federal share would be $566,740 and the local share $155,260. Benefits from damage reduction are estimated to provide a benefit-cost ratio of 1.5 to 1.

To achieve benefits made possible by structural works and other measures, local interests will install necessary land treatment measures for erosion control and flood management estimated to cost $20,000 and urban drainage $50,000, for a total of $70,000. Total cost of installing structural and land treatment measures is estimated to be $792,000.

Reduction of flooding would prevent inundation of a large area of residential development, and would prevent disruption of municipal and business services, thus improving the liveability of the area. Damages to culverts, bridges and roads, along with traffic delays and detours, would be reduced, lessening county maintenance and improving traffic corridors. Health conditions and vector control would be improved within the area affected by flooding.

All channel work would be in the confines of existing channels. There would be noise and dust pollution during construction, and some traffic interruptions.

Lewis Subbasin

Burntbridge Creek Watershed (0-59-1) – This project site lies in the southern portion of Clark County. It originates in rural areas near the community of Orchards and flows westerly through the western edge of Vancouver, and eventually into the Columbia River.

Burntbridge Creek watershed contains 18,659 acres, of which 7,800 acres are classified as urban. Two thousand acres are classified as forest. Seven thousand acres are farmland, and the remainder is in miscellaneous uses such as roads, railroads, airports, etc. The project is designed for flood protection for residential and other urban property, and for agricultural land.

Works of improvement would consist of 12 miles of improved channel and 4.5 miles of buried pipeline, principally in the upper portions of the watershed. Approximately 1.5 miles of channel would have a 4-foot bottom width, 2.5 miles would have a 6-foot bottom width, 4 miles would have an 8-foot bottom width, and 4 miles would have a 10-foot bottom width. The pipeline would be of varying sizes, ranging from 15 inches to 30 inches in diameter.

Installation cost is estimated to be $2,047,000. The federal share would be $1,566,900 and the local share would be $480,000. Benefits from damage reduction are estimated to provide a benefit-cost ratio of 1.8 to 1. To achieve benefits made possible by structural works and other measures, local interests would install necessary land treatment measures for erosion control and flood management estimated to cost $25,000, urban drainage $75,000, and forest production and management practices $5,000, for a total of $105,000. Total cost of installing the structural and land treatment measures is estimated to be $2,152,000.

Flood reduction would prevent inundation of residences and businesses, as well as improve the well-being of people and eliminate disruption of municipal and business services. Damages to culverts, bridges, and roads, along with traffic delays and detours, would be reduced. Highway and street subgrade softening would be prevented. By decreasing these damages, maintenance costs to state and county would be lowered. Health conditions and vector control would be improved within the areas affected by flooding.

About 27 acres of Type I and 8 acres of Type II wetlands would be eliminated. There would be noise and dust pollution during construction, and traffic interruptions.

Salmon Creek Watershed (0-60-1) – This project site is located in the southern portion of Clark County. The top end of the watershed is approximately 1,000 feet above sea level just west of Battle Ground. Salmon Creek flows in a westerly direction, skirting the western edge of Vancouver, and eventually entering the Columbia River. The upper portion of the watershed has a rolling, poorly-drained topography. The residential area of Vancouver has expanded northward into Salmon Creek watershed.

The project would be designed for flood prevention in residential and other urban areas, and for flood protection and drainage of agricultural land. Salmon Creek watershed contains 67,064 acres; 3,400 acres are urban, 25,000 acres are forested, 5,600 acres are rural nonfarm lands, and 31,300 acres are in agricultural use. Gravel pits, roads, and other uses make up the remaining area.

Works of improvement would consist of 32 miles of improved channel, part of which would be enclosed in pipe; the remainder would be open ditch. The project would be designed to provide agricultural flood control so that planting and cultivation of crops can be performed seasonally and damage from inundation eliminated. Flood protection would also be provided for those residential areas which have been constructed in areas with poor drainage.

Installation cost is estimated to be $3,433,000. The federal share would be $2,500,720 and the local share would be $932,280. Benefits from damage reduction are estimated to provide a benefit-cost ratio of 1.2 to 1. To achieve benefits made possible by structural works and other measures, local interests would install necessary land treatment measures for erosion control and flood management estimated to cost $50,000, urban drainage $60,000, and forest protection management practices $10,000, for a total of $120,000. The total cost of installing structural and land treatment measures is estimated to be $3,553,000.

Reduction of flooding would prevent inundation of urban and agricultural areas, as well as improve the well-being of local residents and eliminate the disruption of municipal and business services.

Damage to culverts, bridges, roads, and traffic delays and detours would be reduced. Highway and street subgrade softening would be reduced, thereby lowering maintenance costs for the state and county. Health conditions and vector control would be improved within the areas affected by flooding.

About 50 acres of Type I and 5 acres of Type II wetlands would be eliminated. There would be noise and dust pollution and traffic interruptions during construction. About 30 acres of existing trees and brush along the present channel bank would be eliminated.

EROSION AND SEDIMENT

Projects Under U.S. Department of Agriculture Authority

Early action and later action small watershed projects under P.L. 83-566 authority will provide for an acceleration of land treatment on critical erosion- and sediment-producing sites within the watersheds. Accelerated programs for erosion and sediment control under these projects are expected to benefit about 10 percent of the area of such problem lands. (See Table 68).

Programs Under Department of Agriculture Authority

Ongoing programs of USDA have been summarized in the previous section. These programs, subject to funding, will assist in effecting reduction of erosion and sediment. Many different practices are included in erosion control programs.

On forest roads, erosion control practices include maintaining proper grade, putting in water barriers at intervals to prevent buildup of runoff, placing relief culverts where water accumulates alongside roads, and extending culvert discharge beyond road fills or into chutes.

On clear-cut forest lands, practices include the following: proper location of landings, skid trails and fire trails during logging operations, selection of logging method and size and type of equipment best adapted to the given slope, landform and soil materials, provision for a drainage system that will control the dispersal of surface runoff water from exposed soils and minimize the entry of muddy and turbid water into rivers and streams, and prompt restocking of forest land to stabilize exposed soils.

Only scattered areas of cropland have serious erosion problems because about 85 percent of the cropland is in seeded hay and pasture. On areas where erosion is a problem, conservation measures such as crop residue use, minimum tillage, contour farming, critical area planting, pasture and hayland management, and streambank protection help to reduce the amount of erosion.

Erosion control practices on lands undergoing urban development include critical area planting, debris basins, diversions, mulching, and riprapping.

Tables 70 and 71 give acres and costs of treatment from the present to 1980 and from 1980-2000 for lands having an erosion problem. These estimates do not include streambank erosion.

Table 70. Units and Costs for Erosion and Sediment Control Program to 1980, Southwestern Washington.

Category	Unit	Amount	Cost
National Forest	ac.	15,870	$ 406,100
National Forest Roads	mi.	111	555,000
Private Forest [a/]	ac.	75,630	377,900
Private Forest Roads [a/]	mi.	527	2,635,000
Urban and Agriculture [a/]	ac.	8,000	800,000
Total costs through 1980			$ 4,774,000

Table 71. Units and Costs for Erosion and Sediment Control Program, 1980-2000, Southwestern Washington

Category	Unit	Amount	Cost
National Forest	ac.	63,480	$ 1,904,400
National Forest Roads	mi.	445	2,225,000
Private Forest [a/]	ac.	302,520	1,512,600
Private Forest Roads [a/]	mi.	2,112	10,560,000
Urban and Agriculture [a/]	ac.	32,000	3,200,000
Total costs 1980-2000			$19,402,000

Source: River Basin Planning Staff.

a/ Technical assistance, and in some instances, cost-sharing estimated at 10 percent of the total, could be provided by USDA.

Not all of the $24.2 million needed for erosion and sediment control would be additional money. Approximately 55 percent would be available through many of the USDA programs as described under the section on existing water and related land resource programs, and from private and corporate owners. The remaining 45 percent would have to be in addition to that already being spent under ongoing programs.

Forest management is essential to good watershed management. There is a need for careful planning of road construction and timber harvest operations in order to minimize any adverse influence on soil and watershed values. In the past, ample consideration was not always given to soil and watershed protection. As a result, there has been an accumulation of erosion control and sediment reduction projects which need to be completed. The Forest Service has an inventory of these projects and now needs accelerated funding to complete them. The needed work and the required money would be in addition to that shown in Tables 70 and 71. Table 72 gives the nonrecurrent program of the Forest Service that needs accelerated funding on national forest lands through the year 2000.

Table 72. Nonrecurrent Erosion and Sediment Control Program Requiring Accelerated Funding on National Forest Lands Through 2000, Southwestern Washington.

Item	Unit	Amount	Cost (dollars)
Gully Stabilization	Mile	75	150,000
Erosion Control	Acre	3500	1,041,000
Stream Improvement	Mile	245	4,925,000
Road & Trail Improvement	Mile	1390	502,000
Total----------			6,618,000

A streambank erosion control program is needed on many rivers and streams throughout the Basin. The United States Department of Agriculture can provide technical assistance and cost-share funds toward costs of streambank stabilization. The U.S. Forest Service takes care of all work on streams within National Forest Boundaries.

Types of treatment needed vary with amount and extent of streambank erosion in a particular area, amount of damage from erosion and sediment both onsite and downstream, and ease of access to the area needing treatment. Treatment practices range from seeding of banks to shaping and reducing bank slopes, to rock riprapping in hard-to-stabilize areas.

Vegetation of the proper type, if protected from traffic, is effective in controlling wind erosion of dunes along the beaches of Southwestern Washington.

There are portions of about 205 miles of streambanks with serious erosion problems and portions of 2,050 miles of moderate erosion problems. Because of USDA cost-share limitations and small short-term benefits in relation to cost, less than 10 percent of needed treatment is expected to be done under ongoing programs. Table 73 gives a breakdown of areas with streambank erosion and estimated costs of treatment.

Table 73. Areas with Streambank Erosion and Costs of Treatment, Southwestern Washington. a/

Erosion	Treatment by 1980 (miles)	Cost	Treatment by 2000 (miles)	Cost
Serious	805 b/	$24,150,000		
Moderate			2,050 b/	$37,134,000
Total	805	$24,150,000	2,050	$37,134,000

a/ Only portions of each mile need treatment.

b/ Included is the Forest Service program on National Forest areas, covering about 235 miles, and costing $7,790,000.

Beach and shoreline erosion is a problem in certain areas of the Olympic, Chehalis and South Coastal subbasins. Either program or project action is needed to reduce this erosion. Types of action depend on seriousness of erosion. Program action, such as establishing or re-establishing vegetation, fencing to prohibit access to erosion-prone areas, and paving or boardwalks to concentrate people in certain areas, can be used where erosion is not extremely serious. The Department of Agriculture has authority to cost-share with local units of government on these practices in the Columbia-Pacific RC&D area.

Problems which require large project action, such as shore erosion requiring heavy riprap or jetties to divert ocean tides, are outside the realm of USDA and are normally handled by the U.S. Army Corps of Engineers (Department of Defense).

It has been determined that approximately 45 miles of beach and shoreline need treatment by 1980, and 45 miles need treatment between 1980 and 2000. This treatment is for the Chehalis and South Coastal subbasins. Quantitative figures are not available for the Olympic subbasin.

Of the 45 miles needing treatment before 1980, about 25 miles could be stabilized through USDA programs and 20 miles by project action. The cost of program treatment would be about $250,000. USDA project treatment on the 45 miles needing treatment after 1980 would cost about $450,000.

FLOODWATER

Projects Under Authority of U.S. Department of Agriculture

Seventeen of the early action multipurpose projects identified as having potential under provisions of the Small Watersheds Act (P.L. 83-566) have flood prevention as a principal purpose. In most cases, these projects would provide benefits such as recreation, drainage, and municipal and industrial water supply, in addition to floodwater damage reduction.

All 17 projects may include land treatment measures and structural and nonstructural measures. Land treatment measures would reduce runoff and sediment, improve drainage of agricultural and urban lands, and improve forest protection and management. Structural measures vary with the particular project, but include dams and reservoirs, channel work, pumping plants, dikes and floodgates. Nonstructural measures such as land use regulations, floodproofing, and tax incentives, as appropriate, may also be included. Total cost of the projects, including land treatment costs, would be $29,564,000. Of this total, approximately $15,900,000 would be from federal funds and $13,664,000 would be from local sources. It is estimated that approximately 15 percent of areas suffering urban flooding and 10 percent of agriculatural lands being flooded will be benefited by these projects (Table 68).

Projects of Other Agencies

The U.S. Army Corps of Engineers has planning studies under consideration or in progress affecting problems on the Chehalis River and along the Pacific Ocean near Ocean Shores and Westport in the Chehalis subbasin, lower Willapa River in the South Coastal subbasin, upper Cowlitz River in the Cowlitz subbasin, and Lake River, Lower Kalama River, Columbia River and Vancouver Lake in the Lewis subbasin.

Programs Under Department of Agriculture Authority

Recent approaches to the solution of flooding problems is based on attempts to control flood plain land use (U.S. Water Resources Council, 1971). Flood Control Laws for the State of Washington and the 1971 Shorelines Management Act provide the legal authority for development of comprehensive flood plain management programs (Flood Control Laws, 1971). These authorities recognize that flood plain areas can seldom be considered damage-free, but that proper planning and use of flood plain lands can minimize the damages of floods and public costs of providing protection.

USDA, Soil Conservation Service - An identification has been made of flood plain information study needs in Southwestern Washington that could be implemented by 1980. These studies could be federally funded through USDA programs or otherwise. Table 74 gives the number of studies by subbasin and their total costs. The Soil Conservation Service is able to assist localities with these studies.

Table 74. Numbers and Costs of Flood Plain Information Studies Needed by 1980, Southwestern Washington [a/]

Subbasin	Number of Studies	Total Cost
Olympic	4	$ 88,000
Chehalis	8	180,000
South Coastal	6	124,000
Cowlitz	5	108,000
Lewis	5	115,000
Total	28	$ 615,000

a/ Need for studies developed by the Soil Conservation Service.

Programs of Other Agencies

The U.S. Army Corps of Engineers, U.S. Department of Defense, has a number of flood plain information and floodway designation studies presently underway or planned. These studies involve all subbasins except the Olympic. Future needs identified in Table 75 can also be implemented by the Corps on request.

The U.S. Geological Survey, U.S. Department of Interior, is organized to conduct flood plain information studies, and the Flood Insurance Administration of the Department of Housing and Urban Development utilizes contract consultants to implement such studies. All studies of this type are coordinated by the State Department of Ecology.

The National Insurance Administration (NIA) of the Department of Housing and Urban Development implements the National Disaster Protection Act of 1973. Through this program, flood insurance is available at subsidized rates through private insurance companies, if the legal entity (city or county) applies and qualifies for the program. Federally-related financial assistance such as loans, grants, and guarantees, will not be available after July 1, 1975, in flood hazard areas unless the governmental jurisdiction has qualified for the program and insurance has been purchased. Sixteen cities and towns in Southwestern Washington have qualified for the program, and eight of 11 counties are eligible for the program in unincorporated areas.

Other Programs

Once flood plain information and flood hazard studies have been completed, the state or local community (whoever is legally responsible for flood plain regulation) can implement, as appropriate, a variety of means to accomplish an effective flood plain management program. They are:

- Designate Floodways & Encroachment Lines
- Zoning
- Subdivision Regulations
- Building Codes
- Development Policies
- Floodproofing
- Flood Forecasting
- Temporary Evacuation
- Purchase of Development Rights
- Permanent Evacuation
- Open Spaces
- Urban Redevelopment
- Warning Signs
- Tax Adjustment
- Building Financing
- Flood Insurance
- Channel Improvements

Many of the counties, cities, and towns in Southwestern Washington have initiated one or more of these regulations.

IRRIGATION AND DRAINAGE

Programs Under U.S. Department of Agriculture

On-going programs of USDA have been summarized in the previous section. Direct technical assistance to landowners or groups of landowners in solving irrigation and drainage problems or in developing new systems is provided by the Soil Conservation Service through coordination activities of conservation districts. Farmers Home Administration administers programs which assist with financial aspects of onfarm drainage and irrigation. Information and education programs are furnished by the County Extension Service. It is estimated that actions of individual landowners, with USDA technical and financial assistance, will provide solutions to 35 percent of the lands with drainage problems and 65 percent of the lands needing irrigation (Table 68). Actions by small groups of landowners or government entities with USDA assistance are expected to be effective in providing solutions to about 40 percent of the lands with drainage problems and 15 percent of those lands which need benefits of irrigation (Table 68).

Projects Under U.S. Department of Agriculture

Table 69 lists five early action small watershed projects with opportunity for drainage benefits. In addition, the South Fork Willapa River and Bear River (A'chote) projects have irrigation opportunities. It is estimated that those projects will provide solutions to about 10 percent of the lands with drainage and irrigation problems (Table 68). Later action projects under P.L. 83-566 authority are expected to solve 15 percent of existing drainage problems and 10 percent of lands needing irrigation.

Projects of Other Agencies

The U.S. Bureau of Reclamation has studied dams and reservoirs in the Chehalis subarea which have irrigation as a principal purpose. The projects concern lands in the Pe Ell, Doty, Boistfort, Adna and Napavine areas. These projects have future potential even though present evaluations do not indicate economic feasibility.

Projects on the South Fork of the Willapa River and on Bear River in the South Coastal subarea have been studied. The latter site (A'chote) is an enlarged version of the project indicated for early action under USDA auspices.

If a project under USDA authority does not provide adequate water storage for multiple use needs, a larger USBR project would be an alternative solution. Present economic evaluations do not favor these projects.

MUNICIPAL, INDUSTRIAL AND RURAL WATER SUPPLY

Projects Under Department of Agriculture Authority

The Soil Conservation Service has identified 6 of 18 early action small watershed projects as having a potential for a dam and reservoir. These 6 projects could include municipal and industrial (M&I) water supply as a purpose. The projects are: Salzer-Coal Creek near Chehalis; Coffee Creek (Zenner Valley) project north of Centralia; McCleary Project near the town of McCleary; Newman Creek project north of the town of Elma; South Fork of the Willapa River project east of Raymond; and Bear River (A'chote) project, east of the south end of Willapa Bay (Table 69).

Potential sites for the storage of water to satisfy future needs have been identified. Fifty-two are in the Chehalis subbasin, 49 in the South Coastal subbasin, 13 in the Lewis subbasin, six in the Cowlitz subbasin and three in the Olympic subbasin. No foundation, cost or benefit studies have been made. In some cases, urban development or highly productive agricultural land located in the potential reservoir site may make the site undesirable. Figure 10 gives a general location of potential reservoir sites in Southwest Washington. Tables 75-79 inclusive show name, location, height of dam, storage capacity, and surface area for each potential reservoir in the five subbasins of Southwestern Washington.

In addition to surface water, additional water supplies could come from ground water sources. The Farmers Home Administration (FmHA) can loan money for developing water supply sources (both surface and subsurface) and for distribution and storage facilities. All rural areas, and cities and towns with less than 10,000 population, are eligible to apply for these loans.

A more detailed discussion of water supply entitled "Municipal, Industrial and Rural Water Supply in Southwest Washington" has been written by the Washington State Department of Social and Health Services for the Department of Ecology. This publication estimates that the area will need to spend over $70 million for improvements and maintenance for water supply through the year 2020.

Projects of Other Agencies

Department of the Interior – The Bureau of Reclamation has studied potential dam and reservoir sites in the Chehalis and South Coastal subbasins. (See Irrigation and Drainage). While all would have irrigation as their primary objective, municipal and industrial water could also become a project purpose.

FIGURE 10

U.S. DEPARTMENT OF AGRICULTURE SOIL CONSERVATION SERVICE

Table 75. Potential Reservoir Sites by Watershed, Olympic Subbasin [a/]

Watershed Number and Name	Reservoir Name and Site No.		Location Sec.	Location Twp.	Location Rng.	Dam Height (feet)	Annual Yield [b/] (1,000 ac. ft.)	Storage Capacity (1,000 ac. ft.)	Surface Area (acres)	Drainage Area (100 acres)
0-87 Pysht River	Pysht	115	18	31N	12W	110	153	43	1,300	260
0-88 Clallam River	Last Creek	116	28	32	12W	130	23	19	576	38
0-98 Hoh River	Hoh	122	34	27	12W	130	1820	159	3,320	1670

a/ This partial listing of potential reservoir sites was prepared from topographic maps. Topography only was considered and no foundation or benefit studies were made.
b/ Estimated water runoff at site.

Table 76. Potential Reservoir Sites by Watershed, Chehalis Subbasin [a/]

Watershed Number and Name	Reservoir Name and Site No.	Location			Dam Height	Annual Yield [b/]	Storage Capacity	Surface Area	Drainage Area
		Sec.	Twp.	Rng.	(feet)	(1,000 ac. ft.)	(1,000 ac. ft.)	(acres)	(100 acres)
6-1 Wynoochee River	Black Creek 103	24	18N	8W	50	44	8	498	131
6-1 " "	Oxbow 105	12	21	8W	295	499	276	3,489	460
6-2 Satsop River	Dry Run Creek 104	22	19	6W	40	16	3	249	36
6-2 " "	West Fork Satsop 117	33	19	7W	120	306	90	2,043	529
6-3 Cloquallum River	Falls Creek 106	13	18	6W	45	8	5	349	17
6-4 Newman Creek	Newman Creek 110	21	18	7W	55	19	6	598	44
6-5 Newaukum River	Bear Creek 81	35	14	1W	115	84	36	837	200
6-5 " "	Alpha Creek 82	12	13	1E	220	72	54	668	170
6-5 " "	South Fork Newaukum 83	23	13	1E	100	102	32	1,047	241
6-5 " "	North Fork Newaukum 84	17	13	1W	90	167	71	2,094	396
6-5 " "	Lucas Creek 85	31	13	1E	85	17	6	199	62
6-5 " "	Middle Fork Newaukum 86	15	13	1W	40	17	1	120	48
6-6 Skookumchuck River	Salmon Creek 71	12	15	1W	75	7	2	110	25
6-7 Stearns Creek	Stearns Creek 124	24	13	3W	85	30	18	1,206	168
6-8 S. Fork Chehalis River	Above Hanlon 62	2	10	4W	100	24	7	269	39
6-8 " " " "	Hanlon Creek 61	34	11	4W	75	20	2	110	32
6-8 " " " "	Below Trout Creek 60	19	11	3W	100	72	5	159	123
6-8 " " " "	Point Hill 79	31	12	3W	80	115	50	1,495	229
6-8 " " " "	Boistfort 78	24	12	4W	100	142	100	1,405	243
6-8 " " " "	Lost Creek 57	10	12	4W	60	17	6	349	39
6-8 " " " "	Lake Creek 58	21	12	3W	100	21	40	1,037	49
6-8 " " " "	Stillman Creek 59	2	11	4W	100	34	4	130	58
6-9 W. Fork Chehalis River	Charlies Hump 74	3	12	5W	240	296	95	1,057	441
6-9 " " " "	Dryad 72	11	13	5W	80	306	27	1,256	454
6-9 " " " "	Meskill 76	10	13	4W	90	672	50	2,910	1002
6-8 South & West Forks, 6-9 Chehalis River	Ruth 77	13	13	4W	50	953	20	3,000	1420
6-10 Elk Creek	Little Elk Creek 50	32	14	6W	75	16	9	399	37
6-10 " "	Elk Creek 51	35	14	6W	55	63	11	638	149
6-10 " "	Doty 73	8	13	5W	115	125	81	1,405	298
6-11 Hope Creek	Hope Creek 56	8	13	4W	75	12	8	319	36
6-12 Deep Creek	Bunker Creek 53	26	14	4W	40	29	6	478	97
6-12 " "	Upper Deep Creek 52	12	14	4W	25	3	3	120	10
6-12 " "	Deep Creek 54	25	14	4W	75	18	9	379	60
6-13 West Chehalis River	Scammon Creek 55	11	14	3W	55	4	3	150	20
6-14 Salzer Creek	Salzer 75	26	14	2W	75	8	12	508	42
6-14 " "	Lower Salzer 80	15	14	2W	50	15	6	299	81
6-15 Lincoln Creek	North Fork Lincoln 32	36	15	4W	75	7	12	449	37
6-17 Black River	Waddell Creek 69	21	17	3W	50	24	3	209	79
6-18 Oakville Elma	Sherman Creek 68	35	17	4W	85	29	6	239	85
6-19 S. Side Chehalis River	Workman Creek 65	16	17	6W	50	15	3	209	58
6-19 " " " "	Delezene Creek 64	24	17	6W	60	22	5	299	85
6-19 " " " "	Rock Creek 63	12	16	6W	75	24	5	209	55
6-19 " " " "	Kellogg Creek 67	8	15	5W	75	6	4	150	15
6-19 " " " "	Independence Creek 70	15	15	4W	100	17	48	1,495	96
0-109 Humptulips River	Deep Creek 49	30	19	10W	100	14	12	249	32
0-109 " "	Upper West Fork 121	23	22	9W	150	221	32	578	239
0-109 " "	Lower West Fork 120	8	21	9W	120	324	47	1,047	351
0-109 " "	Upper East Fork 119	4	21	8W	180	150	35	508	139
0-112 Wishka River	East Fork Wishka 118	25	19	9W	170	72	66	1,307	116
0-115 Southeast Grays Harbor	Charley Creek 21	26	17	9W	55	10	3	159	21
0-117 Elk River	Middle Branch 31	31	16	10W	45	7	1	90	14
0-117 " "	East Branch 33	5	15	10W	65	19	5	269	44

a/ This partial listing of potential reservoir sites was prepared from topographic maps. Topography only was considered and no foundation or benefit studies were made.

b/ Estimated water runoff at site.

Table 77. Potential Reservoir Sites by Watershed, South Coastal Subbasin a/

Watershed Number and Name	Reservoir Name and Site No.	Location Sec.	Location Twp.	Location Rng.	Dam Height (feet)	Annual Yield b/ (1,000 ac. ft.)	Storage Capacity (1,000 ac. ft.)	Surface Area (acres)	Drainage Area (100 acres)
0-65 Abernathy Creek	Mill Creek	66	7	9N 4W	85	14	2.4	90	18
0-65 " "	Upper Abernathy	88	9	9 4	100	33	2.4	80	47
0-67 Elochoman Creek	Elochoman	28	31	9 5	125	300	60.0	1,400	408
0-70 Grays River	Malone Creek	42	22	10 8	40	13	1.0	90	17
0-70 " "	Grays River	27	19	11 6	100	176	16.0	490	220
0-75 Chinook River	Chinook	123	16	9 10	130	6	4.8	100	15
0-120 Cedar River	North Fork Cedar	29	27	15 11	35	12	1.2	120	29
0-120 " "	East Fork Cedar	30	30	15 10	65	3	2.7	130	[illegible]
0-122 North River	Lower Rainie Creek	22	3	15 6	85	14	4.2	150	43
0-122 " "	Upper Rainie Creek	24	36	16 6	75	3	2.2	100	8
0-122 " "	Fall River	25	16	14 6	65	38	3.1	150	87
0-122 " "	Dean Creek	26	6	14 6	75	8	2.8	120	20
0-122 " "	Upper Pioneer Creek	23	21	16 6	90	4	6.2	220	14
0-122 " "	Upper North River	109	22	16 8	40	372	42.7	3,600	745
0-122 " "	Big North River	44	6	15 9	115	690	220.0	7,910	1217
0-122 " "	Pacific	35	14	15 10	40	15	1.6	130	29
0-122 " "	Grays Harbor	34	3	15 10	45	5	1.2	90	9
0-122 " "	Lower Salmon Creek	46	10	15 9	80	33	22.5	860	80
0-122 " "	Salmon Creek	38	10	16 8	75	30	18.6	770	78
0-122 " "	Little North River	39	35	17 8	75	18	9.4	380	47
0-122 " "	Leach Creek	36	28	16 7	80	8	4.0	150	15
0-122 " "	Vesta Creek	40	14	16 7	75	40	17.5	720	114
0-123 Smith Creek	Elkhorn Creek	47	22	15 9	105	149	117.0	3,350	353
0-123 " "	Upper Elkhorn	37	16	15 8	75	19	7.5	310	36
0-124 Ward Creek	Upper Ward Creek	18	22	14 8	80	75	22.5	860	125
0-124 " "	Wilson Creek	17	30	14 7	80	67	12.0	480	113
0-124 " "	Whitcomb Creek	41	26	14 8	65	13	6.8	190	28
0-126 Willapa River	West Mill Creek	5	7	13 7	80	63	7.5	340	108
0-127 S. Fork Willapa River	Rue Creek	48	7	13 8	195	100	80.9	1,180	192
0-127 " " " "	Minnie Creek	12	24	13 8	100	62	13.5	410	93
0-128 Canon River	Lower Canon River	13	31	13 10	115	50	5.7	150	91
0-128 " "	Canyon Creek	14	29	13 9	65	10	2.8	130	20
0-128 " "	Upper Canon River	15	32	13 9	95	15	3.6	120	31
0-128 " "	Palix River	11	13	13 10	95	35	12.6	180	74
0-128 " "	Upper N.F. Palix River	19	7	13 9	50	12	3.6	230	28
0-129 North Nemah River	Upper North Nemah	8	2	11 9	105	23	4.3	120	40
0-129 " " "	Lower North Nemah	10	34	12 9	55	29	1.3	80	50
0-129 " " "	North Nemah	125	30	12 9	85	66	9.4	670	110
0-129 " " "	Williams Creek	16	18	12 9	85	25	7.2	130	53
0-130 Middle Nemah River	Upper Middle Nemah	7	8	11 9	95	27	2.9	100	47
0-130 " " "	Lower Middle Nemah	9	31	12 9	100	32	2.9	90	56
0-133 Clearwater Creek	Clearwater	20	10	11 10	80	4	2.2	90	7
0-137 Bear River	Bear Branch	43	20	10 10	30	41	1.2	130	80
0-137 " "	Upper Bear Branch	45	35	10 10	105	20	16.6	300	41
0-138 Naselle River	Lower Naselle	1	25	11 9	85	132	11.2	400	306
0-138 " "	Upper Naselle	2	14	11 8	130	58	9.2	200	63
0-139 Salmon Creek	Upper Salmon	3	27	11 8	100	26	8.3	250	34
0-139 " "	Middle Salmon	4	28	11 8	65	42	1.8	90	55
0-139 " "	Lower Salmon	6	32	11 8	60	60	5.5	280	80

a/ This partial listing of potential reservoir sites was prepared from topographic maps. Topography only was considered and no foundation or benefit studies were made.

b/ Estimated water runoff at site.

Table 78. Potential Reservoir Sites by Watershed, Cowlitz Subbasin [a/]

Watershed Number and Name	Reservoir Name and Site No.	Location			Dam Height	Annual Yield [b/]	Storage Capacity	Surface Area	Drainage Area
		Sec.	Twp.	Rng.	(feet)	(1,000 ac. ft.)	(1,000 ac. ft.)	(acres)	(100 acres)
23-14 Olequa Creek	Brim Creek	87	23	11N 3W	75	10	7	299	39
23-17 Ostrander Creek	Ostrander Creek	89	28	9 1W	75	5	3	100	52
23-5 Tilton River	Tilton River	91	24	13 2E	305	476	240	2,012	819
23-13 Salmon Creek	Cedar Creek	92	14	11 1E	85	12	10	398	71
23-13 " "	Salmon Creek (1)	93	20	11 2E	120	16	35	896	78
23-13 " "	Salmon Creek (2)	94	30	11 2E	120	4	20	498	19

a/ This potential listing of reservoir sites was prepared from topographic maps. Topography only was considered and no foundation or benefit studies were made.
b/ Estimated water runoff at site.

Table 79. Potential Reservoir Sites by Watershed, Lewis Subbasin [a/]

Watershed Number and Name	Reservoir Name and Site No.		Location Sec.	Twp.	Rng.	Dam Height (feet)	Annual Yield [b/] (1,000 ac. ft.)	Storage Capacity (1,000 ac. ft.)	Surface Area (acres)	Drainage Area (100 acres)
22-1 Lewis River	Meadow Creek	107	20	7N	8E	90	93	18	1,547	157
22-1 " "	Big Creek	108	18	7	8E	120	98	34	900	166
22-1 " "	Cedar Creek	113	13	5	3E	55	104	9	1,285	246
22-4 East Fork Lewis River	E. Fork Lewis River (1)	95	4	4	1E	85	433	90	3,515	1311
22-4 " " " "	E. Fork Lewis River (2)	112	19	4	4E	230	447	79	1,088	676
0-56 Washougal River	Washougal River	111	26	2	5E	270	215	78	904	370
0-58 Lacamas Creek	Lacamas Creek (1)	97	10	2	3E	55	34	8	342	85
0-58 " "	Lacamas Creek (2)	96	3	2	3E	35	32	2	201	79
0-60 Salmon Creek	Salmon Creek (1)	102	20	3	2E	45	65	3	201	185
0-60 Salmon Creek	Salmon Creek (2)	101	4	3	3E	75	48	9	372	121
0-61 Ridgefield Area	Gee Creek	98	29	4	1E	55	22	1	80	62
0-63 Kalama River	Kalama (1)	90	33	7	1W	100	250	95	422	833
0-63 " "	Kalama (2)	114	20	7	3E	370	262	154	1,285	436

a/ This potential listing of reservoir sites was prepared from topographic maps. Topography only was considered and no foundation or benefit studies were made.
b/ Estimated water runoff at site.

Power Projects – All three reservoirs built by Puget Sound Power and Light on the North Fork of the Lewis River, and two reservoirs built by Tacoma City Power & Light on the Cowlitz River, could be used for municipal and industrial water. Several factors. including lack of benefits to cover costs, preclude this possibility at the present time. Conditions could change in the future, and then these M&I water supply sources could become definite alternatives.

Programs of Other Agencies

United States Geologic Survey (USGS) is currently conducting a study of ground water availability on Long Beach peninsula. This study is to determine location and quantity of water available, and whether water quality is acceptable.

WATER QUALITY

Programs Under the Department of Agriculture

The United States Department of Agriculture assists in long range planning to meet additional water quality problems caused by increased population, industry, agriculture, irrigation, fish enhancement and recreation, through development of multipurpose water supply systems.

The USDA also assists in promoting adequate monitoring and control techniques to reduce water pollution, or eliminate it. Assistance could be provided for installation of monitoring systems.

The Soil Conservation Service assists local governments to implement solid waste management plans by identifying sites with suitable soils, to avoid potential water pollution problems.

Programs of Other Agencies

The Environmental Protection Agency (EPA) represents federal interests in water pollution control programs and water quality standards federally established. Close working relationships with appropriate state agencies are maintained by EPA. The state legislature has displayed concern for the preservation and protection of adequate and safe supplies of potable water to satisfy human domestic needs (90.54.020 RCW). The Department of Ecology (DOE) and the Department of Social and Health Services, Division of Health, are state agencies which are most directly involved with programs which deal with water quality problems of various kinds.

Non-point sources contributing to sedimentation are a problem associated with agriculture and forestry. EPA expects these standards to be met through state agency efforts. The Washington State Departments of Ecology and Natural Resources are attempting to deal with forest related non-point sources via the State Forest Practices Act, which establishes notification, permit, and operational standards for road construction, silvicultural, and harvesting activities.

Housing development on wet soils.

Housing development on good soils. Douglas Fir trees were saved during construction for improved environment.

Red Alder trees saved during construction. Native vegetation near the base of trees has also been preserved.

Some lands are unsuitable for housing developments, even though during some seasons there is little evidence of this fact. USDA Soil Surveys are useful in identifying hazardous sites for housing and other specialized uses of land.

LAND USE

Programs Under the Department of Agriculture

One of the programs administered by the Department of Agriculture is the Forestry Incentives Program created by Congress in 1973. Lands owned by the forest industry and by the public are being planted and improved at the fastest rate possible, however most small owners, who control much of the forest land in the Basin, do not have the funds to make such long-term investments. The Forestry Incentives Program is designed to share tree planting and forest management expenses with the small owner.

Interpretations about specific uses of soil were made as a part of this study. One of the uses considered was for septic tank absorption fields. Septic tank absorptive field limitations are intended to aid with preliminary site selection and evaluation for septic tank installations. This information, along with onsite tests and records of performance for existing absorption fields, should be used by developers to prevent situations where houses are constructed on sites completely unsuited for septic tank installations.

The Department of Agriculture administers a program for small, rural communities that have sanitary sewerage problems. It is administered by the Farmers Home Administration (FmHA) and its purpose is to provide loans which can be used on a cost-sharing basis to design and construct sewer systems. Information about this program can be obtained from the county office of FmHA.

Many problems affecting existing agricultural land use which directly and/or indirectly concern the residents of the Southwestern Washington Basin can be relieved by ongoing U.S. Department of Agriculture programs. Others require the development and implementation of state and local policies. If preservation of prime agricultural land is desired, the most restrictive action that can be taken by local policymakers is to zone lands for specific uses. Agriculture could be one of these uses.

As stated earlier, control of tansy-ragwort or other noxious weeds on agricultural lands requires an intensive, long-term program. USDA does not have a specific program designed for weed control. However, it does have specialists within the various agencies who are knowledgeable about methods of weed control and proper handling of control agents. Individuals or groups, such as weed control districts, are encouraged to work with USDA personnel on comprehensive control programs. Contact with the department should be made through the county offices of the ASCS, SCS or Extension Service.

Programs of Other Agencies

The state has several laws governing land use and development. The Forest Land Tax Act (Substitute House Bill 1185) was signed into law by the Governor on May 6, 1974. This law provides tax incentives for owners who dedicate their land to timber production. Under this law, designated forest land is taxed annually, based on established bare land values, with taxes on timber values delayed until harvest.

The Open Space Taxation Act is another state program where landowners may apply for classification of land into one of three categories in return for tax incentives. The three classifications are open space land, farm and agricultural land, and timberland. Once land is so classified, it cannot be diverted to any other uses for a period of 10 years, without penalty. Owners who violate the terms of their agreement with the state are subject to applicable taxes, penalties, and interest on the amount due.

The Shoreline Management Act of 1971 requires local governments to prepare master programs which provide objective guides for the use of shorelines. The programs clearly state local policies for the development of shorelands and how these policies relate to specific regulations affecting physical development of land and water resources throughout the local government's jurisdiction. Owners and developers who wish to make significant changes in land use along shorelines should refer to the county shoreline master programs and confer with county officials to ascertain that they are in agreement on development of shorelines.

Control of tansy-ragwort or other noxious weeds is generally a program that must be initiated by landowners. An effective way to accomplish this is through formation of weed control districts under state law which coordinate the program, keep members informed on proper methods of control, and work with local representatives of state and federal agencies for solution of the problems.

In the past, the state has recognized the detrimental effect of tansy-ragwort on livestock operations and has required control of the weed on forest land for 200 feet from pastures. A new law requires forest owners to control this weed 1,000 feet from pastures.

USDA programs are designed primarily to assist private landowners, although public and corporate landowners may also receive technical assistance/ Jurisdiction for control of land use problems lies with the Departments of Natural Resources, Ecology, and Fisheries; or with counties under one or more of the following: Forest Practices Act of 1974, Shoreline Management Act of 1971, Hydraulics Act, and State Water Quality Standards. These agencies have the authority to insure compliance with the above to preserve forest productivity through proper forest practices and to assure that the quality of streams and rivers is not degraded.

RECREATION

Programs of the Department of Agriculture

In addition to flood control, irrigation and municipal and industrial water supply as purposes in USDA small watershed projects, recreation is also considered. Currently, USDA is studying the possibility of constructing reservoirs on six streams in the area under this program. These reservoirs could be planned to provide opportunities for fishing, swimming, picnicking, boating, camping, and hiking. If all six of the reservoirs were constructed, over 560,000 visitor-days of recreation could be provided annually. Resource Conservation and Development Projects (RC&D), including the existing Columbia-Pacific RC&D in Grays Harbor, Pacific, and Wahkiakum Counties, can provide federal funds for 50 percent of the costs of water-based recreation facilities to eligible local sponsors. USDA offers onsite technical assistance to private landowners in solving soil and water management problems associated with development of recreational facilities.

The Forest Service has an ongoing program to provide recreation, one of the uses for which national forests are managed. Opportunities provided vary from highly-developed camp and picnic grounds to primitive camps, hiking trails and wilderness for dispersed activities. The Goat Rocks and Mount Adams Wildernesses contain about 80,000 acres. Another 57,000 acres is presently being considered for designation as "Wilderness". In order to meet the projected need for developed sites by the year 2020, the Forest Service will have to develop 126 acres of campgrounds and related facilities.

Programs of Other Agencies

The Olympic and Mount Rainier National Parks are managed by the National Park Service to preserve their natural beauty for the enjoyment of all. Campgrounds, picnic grounds, interpretive centers and trails are developed to the extent appropriate with this objective. Wilderness proposals are being considered within both parks. In order to meet demands projected for the year 2020, nearly 700 acres of national park lands will need to be developed for campgrounds and related facilities. This acreage, and others shown in this section, assume that each agency will continue to provide facilities in the same ratio existing in 1970.

Washington State provides for recreation needs principally through its Department of Parks and Recreation and the Department of Natural Resources. Parks and Recreation can also participate with local entities by providing 75 percent of facility development costs. Parks and Recreation facilities are usually highly developed. There are several undeveloped parcels managed by the Department which may be developed to meet future needs. The Department of Natural Resources provides smaller, less developed campgrounds

throughout its extensive forest lands. New sites are developed as needed, as part of an ongoing program. In order to meet projected needs for the year 2020, the State of Washington will have to develop an additional 7,500 acres of campgrounds and related facilities for concentrated uses.

Programs of the Department of Agriculture and other agencies mentioned above are capable of meeting the acreage demands previously expressed. However, it should be noted that management policies of the various departments may preclude attempting to meet this need. For instance, nearly 90 percent of the Olympic National Park is being considered for designated wilderness, and developed sites are discouraged. Also, the demand figures reflect the facility design and the recreation activity demand experienced to date. Both of these may change. One can only conclude that, based on projections of today's recreation demand, many acres of land will need to be dedicated to facility development. Each agency can fulfill a part of this need, but may not do so, thus creating increased pressure on the others.

FISH AND WILDLIFE

There are many opportunities for fish and wildlife habitat improvement within Southwestern Washington.

Programs Under the Department of Agriculture

The Forest Service goal in wildlife management is to maintain and improve the habitat for all species of fish and wildlife on national forest lands. This is accomplished through manipulation of vegetative cover and installation or improvement of feeding, watering, cover or nesting facilities. Special habitat requirements for rare and endangered species are considered, and improved upon, where possible. As part of this program of habitat management, the Forest Service has completed an inventory of jobs to be completed to improve fish and wildlife habitat in Southwestern Washington. The necessary work for the area is shown below.

Program		Unit	Amount	Cost (dollars)
Habitat Survey and Analysis	- Land	acre	765,000	115,000
" " "	- Water	mile	5,625	225,000
Fish Habitat Improvement	- Stream	mile	145	290,000
" " "	- Lake	acre	35	26,250
Big Game Habitat Improvement		acre	3,600	360,000
Waterfowl Habitat Improvement		acre	100	10,000
	Total			1,026,250

In addition, Resource Conservation and Development (RC&D) projects such as the existing Columbia-Pacific RC&D project in Grays Harbor, Pacific, and Wahkiakum Counties can bear 50 percent of the cost of water-based fish and wildlife developments.

Some of the projects included in habitat improvement categories are: construction of watering facilities, stream channel improvement, construction of fish ladders, removal of debris barriers from streams, development of potholes for waterfowl, and planting of food for waterfowl. USDA provides onsite assistance on both private and public lands to help solve soil and water conservation problems relating to the preservation and enhancement of fishery and wildlife habitat through ongoing programs.

Programs of Other Agencies

The Washington Department of Fisheries and the Department of Game have completed inventories of fish and wildlife populations in Southwestern Washington. They have studied limiting factors to production of species within the Basin, and are actively engaged in management of the resources to overcome limiting factors related to man's activities. Their activities depend a great deal upon support from the State Legislature, which appropriates funds for their work. This support has been active in the past, and should continue to be so.

Merriman Falls, Lake Quinault

IMPACTS OF PROPOSED USDA PROJECTS AND PROGRAMS

(Photo by Washington State Department of Commerce and Economic Development)

IMPACTS OF PROPOSED USDA PROJECTS AND PROGRAMS

Proposed USDA projects and programs will affect the physical landscape, environment, culture and economy of the subbasins. Not all of these impacts can be quantified. In some instances, they are not readily identifiable and may not become apparent until a development program is implemented. Needed conservation land treatment and management practices will maintain or improve productivity of the agricultural land of the Basin and enhance utilization of water resources. Action or inaction in one sector directly or indirectly affects the other.

PHYSICAL AND BIOLOGICAL EFFECTS

Hydrology

Installation of floodwater retarding reservoirs and channel modification measures will reduce flood stages on flood plain lands, and land treatment programs will improve runoff conditions in upland areas. Detention structures will temporarily detain flood runoffs, trapping debris and sediment. It is not anticipated that upstream watershed structures and land treatment measures will reduce average annual runoff.

Relatively slow release of floodwater through principal spillway conduits and limited seepage from permanent pools will augment streamflows and increase ground water recharge. Prolonged streamflows will permit more intensive utilization of surface water for livestock, fishing, irrigation, recreation and other environmental uses.

Water Quality

Small watershed projects and associated land treatment programs will enhance the overall quality of water in subbasins by reducing the amount and velocity of runoff, which in turn will reduce erosion and sediment production and delivery. Cropland on which precipitation and irrigation waste water runoff is held to a minimum will contribute less pollutant material, such as agricultural chemicals and soil nutrients, to receiving streams.

Careful consideration should be given to the quality of runoff water expected before multiple purpose impoundments are planned, in order to avoid adverse, near-irreversible effects of eutrophication and other conditions detrimental to fish and wildlife and recreational use of reservoirs.

Sedimentation

Sediment entering streams will be reduced by proper land use, application of proper land treatment and construction of floodwater retarding and grade stabilization structures (which will also provide storage

for sediment). Reduced rates of sedimentation will prolong the life of downstream water impoundments, improve efficiency of drainage systems, maintain a desirable hydraulic capacity in streams, reduce stream turbidity, assist in maintaining soil fertility, and protect fish spawning beds.

Fish and Wildlife

Recommended measures and projects installed through USDA Programs will have a significant impact on fish and wildlife resources. Water impounding reservoirs displayed as early-action projects under P.L. 566 will increase water areas by 2,430 surface acres, and provide lake- or reservoir-type habitat for wildlife. At the same time, 2,430 acres of stream, riparian, and forest-type habitat will be inundated. Later-action P.L. 566 projects, small group action projects, projects carried out by individual landowners or measures installed under RC&D projects, will have both beneficial and adverse effects on fish and wildlife, depending on designs, mitigation success and other factors.

Creation of reservoirs and adjacent shorelands can make significant net contributions toward meeting projected water-based recreation needs in the Basin.

The elimination of wetlands by means of structures designed to improve land drainage and reduce flooding will adversely affect wetland wildlife habitat.

Land treatment measures designed to reduce erosion will decrease the amount of sediment reaching streams, thus contributing to improvement of aquatic habitat. Improved vegetative cover to reduce erosion in upper watershed areas will provide additional cover for wildlife.

A significant impact on recreation and wildlife will occur from a wide variety of private onfarm practices receiving technical and financial assistance through USDA programs. Onfarm drainage systems which improve production of agricultural lands will reduce habitat for certain wildlife species. Construction of farm ponds will furnish wildlife habitat and can satisfy a part of the demand for fishing and hunting. Single purpose wildlife habitat and other wetland developments will provide nesting areas for both waterfowl and upland game birds. The extent of this onfarm type of development depends on financial incentives to make recreation a more profitable enterprise than other alternatives available to private landowners.

Vegetation

Vegetative impacts will come about due to project construction and land use changes. Project construction will tend to dry up wetland and convert it to cropland, pasture or urban. Dams will inundate pasture, wetland and forest land. The overall trend will be a loss of wetland and a gain in cropland and pasture. Some loss in forest vegetation will result from land-use conversion.

ECONOMIC EFFECTS

During 1974, an input-output model was completed for the Southwestern Washington Economic Study Area. Data and results of this study were an updating and aggregation of the 1967 Washington State Input-Output Study, so that the 1969 Census of Agriculture and the 1970 Census of Population could be incorporated as the base period data. Information for this updating procedure was obtained from the State of Washington. The resulting model contained 33 industrial sectors and was utilized to study interindustry changes in gross output resulting from proposed Department of Agriculture projects and programs. The 33 sectors for which possible changes in gross output have been studied are given in Table 80.

Gross output changes derived by input-output procedures account for the interdependence among sectors of the economy. This interdependence accounts for not only direct monetary transactions, but also for interdependence among sectors which are not plainly apparent in the production process.

Land Use

Sufficient acreage is available for land-use conversion to nearly 48,000 acres of additional cropland by the year 2020. Increased production of major agricultural crops will not require similar increases in additional cropland acreage, due to projected increases in crop yields and fertilizer application rates. Land used for forest and woodland will decrease slightly, due to conversion to nonagricultural uses.

Agricultural Production

Production increases in field crops, vegetables, fruits, livestock, meat and milk are projected to have an average annual impact of $2.33 million from 1969-1980. Such increases would induce an annual change in gross output of approximately $3.19 million during this period. From years 1981-2000, the average annual increase in agricultural production is projected to have a change in gross output of nearly $1.82 million, with approximately 65 percent of this increase in the livestock and meat and milk processing sectors.

Table 80. Estimated Average Annual Changes in Gross Output, Southwestern Washington Economic Study Area, 1969-1980 and 1981-2000.

Sector number & name	Change in gross output 1969-1980	1981-2000
	-----Million dollars-----	
1. Field Crops	0.40	0.25
2. Vegetables, fruits & nuts	0.40	0.18
3. Livestock	1.12	0.66
4. Special misc. crops	0.02	0.04
5. Fishing	a/	a/
6. Meat & milk proc.	0.85	0.53
7. Canning & preserving	a/	a/
8. Grain mill, etc.	0.06	0.04
9. Beverages	a/	a/
10. Textile mills	0.01	a/
11. Mining	0.01	0.01
12. Forestry	0.15	0.04
13. Logging	0.64	0.77
14. Sawmills	1.54	2.74
15. Veneer & plywood	0.03	0.03
16. Miscellaneous wood	0.03	0.03
17. Furniture	a/	a/
18. Pulp & paper mills	5.27	2.46
19. Printing, etc.	0.01	0.01
20. Chemicals	0.01	0.01
21. Glass & stone	0.01	0.01
22. Iron & steel	0.04	0.03
23. Heavy & light steel	0.01	0.01
24. Nonelectrical motive	0.05	0.03
25. Processing equipment	0.02	0.01
26. Motor vehicle & equipment	0.02	0.02
27. Other manufacturing	0.02	0.02
28. Transportation services	0.05	0.05
29. Communications, gas, etc.	0.24	0.17
30. Construction	1.12	1.04
31. Trade, wholesale & retail	0.10	0.08
32. Finance, insurance & real estate	0.09	0.07
33. Services	0.14	0.11
Total	12.49	9.45

a/ Less than $10,000.

Outdoor Recreation

By the year 2000, expenditures by those who use the Basin's recreation facilities and adjacent forests, waters and shores will contribute approximately $40 million in direct benefits to the economy of the Basin.

Capital investment for expansion of existing recreational sites and construction of new sites on rivers and reservoirs would have an additional annual economic benefit of about $80,000 through the period 1980. For the period 1981-2000, the average annual benefit should increase to about $88,000 with 36 percent of this increase occurring in the wholesale and retail trade services sectors.

Population and Employment

Employment-induced population increases of 24,577 during the period 1970-1980 are estimated to result in an increase of $28.6 million in total income (constant 1967 dollars). Major changes in employment are expected in the manufacturing, transportation, and services sectors of the Southwestern Washington economy. By the year 2000, total income is expected to increase by an additional $220 million.

Projected employment changes are shown in Table 32. Employment in the area is expected to reach nearly 195,000 by the year 2020.

Primary and Secondary Impacts

Proposed programs and projects of improvement provide stimulus to economic growth and development within the area. Due to the relationships that exist between the various sectors of the Southwestern Washington economy and the rest of the state, it is extremely difficult to measure all effects which are likely to occur. A change in a basic sector, such as forestry or agriculture, will cause changes in other sectors. For example, proposed additions to the forestry, sawmills, and pulp and paper mills sectors to gross output of $76.5 million between 1969-1980 are anticipated to affect the local economy by an additional $6.96 million on an annual basis.

Estimated annual average changes in gross output in the Southwestern Washington economy, excluding project installations, are shown in Table 80 for the period 1969-2000. No attempt was made to analyze impacts through the year 2020. It should be noted that effects of total resource development on field crops, vegetables, fruits, livestock, meat and milk sectors amounted to an additional $0.44 million ($2.77 - $2.33 million) during the period 1969-1980.

COORDINATION AND PROGRAMS FOR FURTHER DEVELOPMENT

COORDINATION AND PROGRAMS FOR FURTHER DEVELOPMENT

Other programs and measures beyond the scope of this report are appropriate for consideration in relation to resource development and management. Technological advances and improved management techniques provide new opportunities for resource development. Modernization of institutional arrangements afford fresh incentives and direction for resource development and management.

Solutions to problems and needs as set forth in this study may not prove practical in all cases. Program changes may be required to implement these solutions, necessitating legislative action. Successful implementation will depend on full coordination with federal, state and local agencies and involvement of local citizens during initial planning and general acceptance by the public of proposed actions.

OTHER AGENCY PROGRAMS

This report has emphasized USDA projects and programs which presently exist to further opportunities for the development of water and related land resources within the Southwestern Washington Basin. Other related federal agency programs and projects have been noted in less detail. Shifts in priorities and new alternatives to present proposals will affect the interrelationship of all agency programs and projects. Periodic reviews will be required to maintain an awareness of latest studies underway, and plans for development, to avoid conflicting developments.

The State Water Plan will establish policy and guidance to development of water and related land resources and will have an effect on future agency projects. New federal programs administered by the state will also influence the design of projects and point out the need for adjustments in existing programs.

COORDINATION OF PLANNING

All planning for development of water and related resources should be closely coordinated, and even jointly planned, with other concerned agencies. The state, in collaboration with affected counties and local interests and through policies developed in the State Water Plan, can effect needed coordination.

Recent interest in problems associated with the Columbia River estuary emphasizes a need to relate planning of tributary watersheds in recognition of these problems and future recommendations to alleviate them.

The U.S. Bureau of Reclamation of the Department of Interior and the U.S. Department of Agriculture through the Soil Conservation Service have independently studied water storage projects on Bear River in the South Coastal subbasin. Limitations of USDA authority to construct reservoirs over a certain size is fundamental to a determination of appropriate agency involvement. After present and future needs for water are realistically determined, the type of project and a planning agency can be selected.

Programs and responsibilities with which state agencies are charged require maximum coordination efforts with plans of federal agencies. These responsibilities periodically change as a result of legislative mandates, and therefore demand frequent assessment to avoid conflicts of project or program purposes.

ALTERNATIVE APPROACHES

The most desirable development of land and water resources of the Basin is a fully coordinated comprehensive program oriented toward a balance of economic, social and environmental objectives. This approach would have a combined effect of improving economic and environmental conditions by reducing flood losses, enhancing agriculture, providing needed supplies of water, and preserving environmental values.

An alternative to a coordinated comprehensive approach to water resource developments would be unilateral installation of projects and related structures without regard to relationships to or effects on other projects. As a result, overlapping developments and competition for structure sites and project installations which might later conflict with other plans would occur. USDA projects in small upstream watersheds would not by themselves relieve problems of large downstream flood plains, which emphasizes the need for coordination of projects to achieve maximum benefits.

Plans primarily oriented toward environmental objectives would emphasize development of public recreation, fish and wildlife development, preservation of natural vegetation, pollution abatement, water quality improvement and beautification. Limitation of full economic development may be a result of such an alternative, although some new economic potentials related to recreational enterprises would be created. Present USDA programs could not fully implement environmentally oriented plans; although, with correlation of available program resources, many of the objectives of such a plan would be realized.

A balanced comprehensive plan should include consideration of structural as well as nonstructural measures which control urban-industrial use of hazardous flood plain lands or lands with other limitations to development. An alternative would be to implement only nonstructural features of a plan which would prevent future development of unfavorable sites, but would have little effect on current or projected damages to existing developments.

NORTHHEAD LIGHTHOUSE ON THE PACIFIC OCEAN NEAR ILWACO

(Photo by Wash. State Dept. of Commerce and Economic Development)

NEW PROGRAMS OR MODIFICATIONS

Some existing programs have become outdated, and are therefore not completely effective in providing lasting solutions to present day problems and needs. Outmoded programs should be reviewed and updated to maximize benefits from solutions presented in the report. Programs which are organized to emphasize short-term solutions to problems could be redesigned to offer extended benefits. Programs which treat problems at points of impact could be reorganized to deal with problems at their source. Increased effectiveness and reduced costs could conceivably result from such program changes.

Accelerated land treatment programs presently associated with USDA small watershed projects under authority of Public Law 566 would increase the effectiveness and prolong the usefulness of larger projects installed by other federal agencies. Appropriate land treatment measures compatible with primary use should extend to all public reservoirs.

Program incentives need to be restudied and modified so that adequate encouragement is given to alternatives which avoid future problems and public expenditures to correct errors associated with inadequately planned developments.